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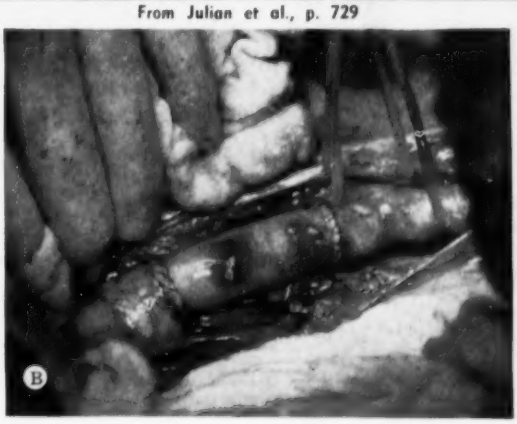

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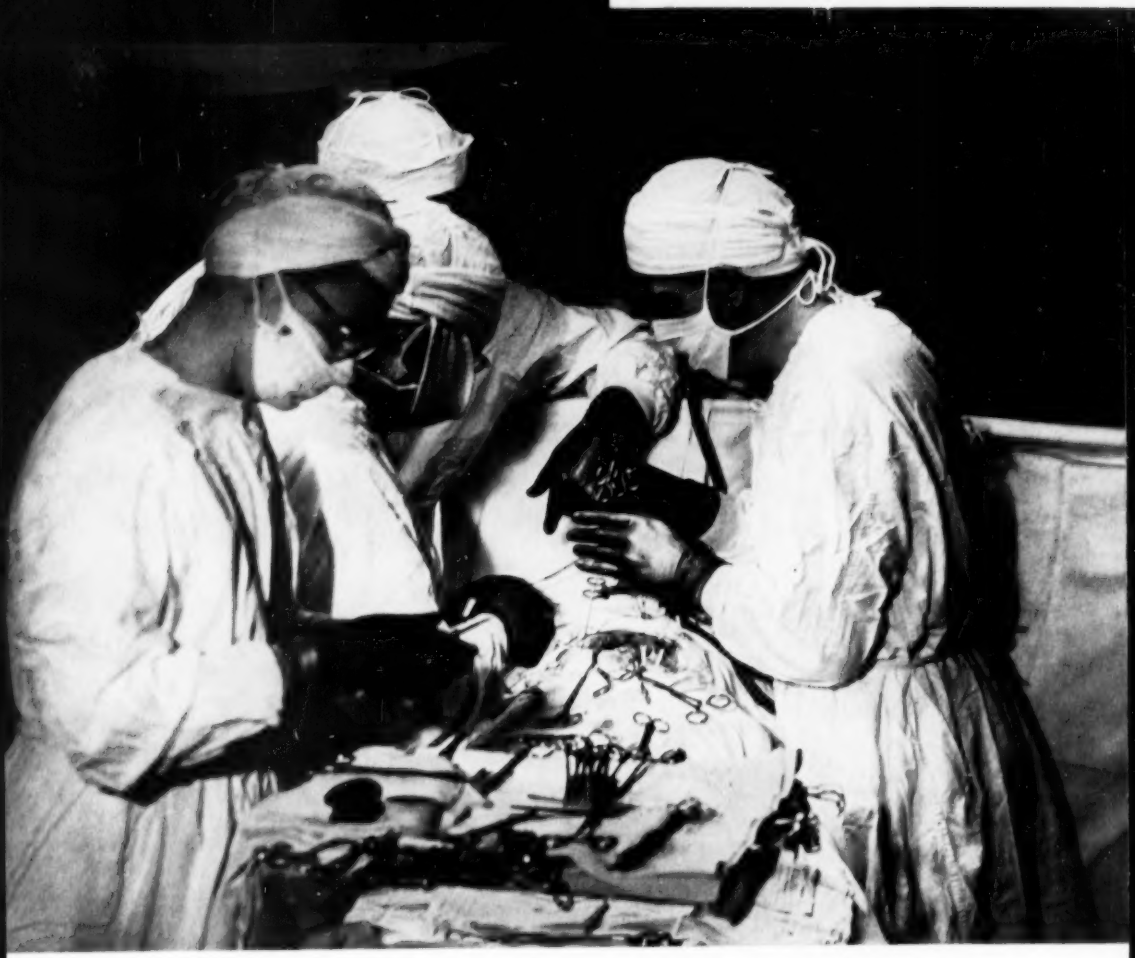

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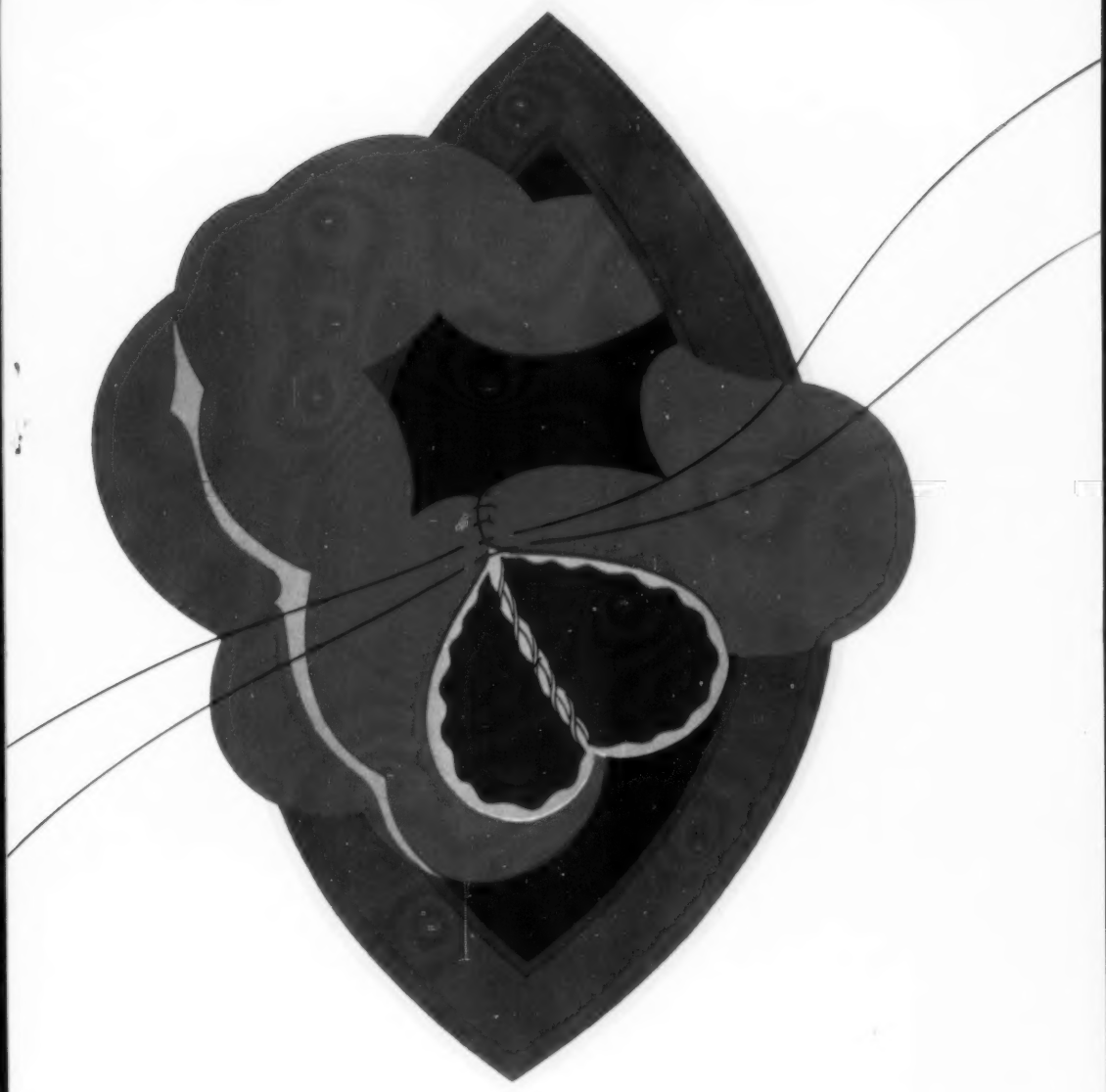

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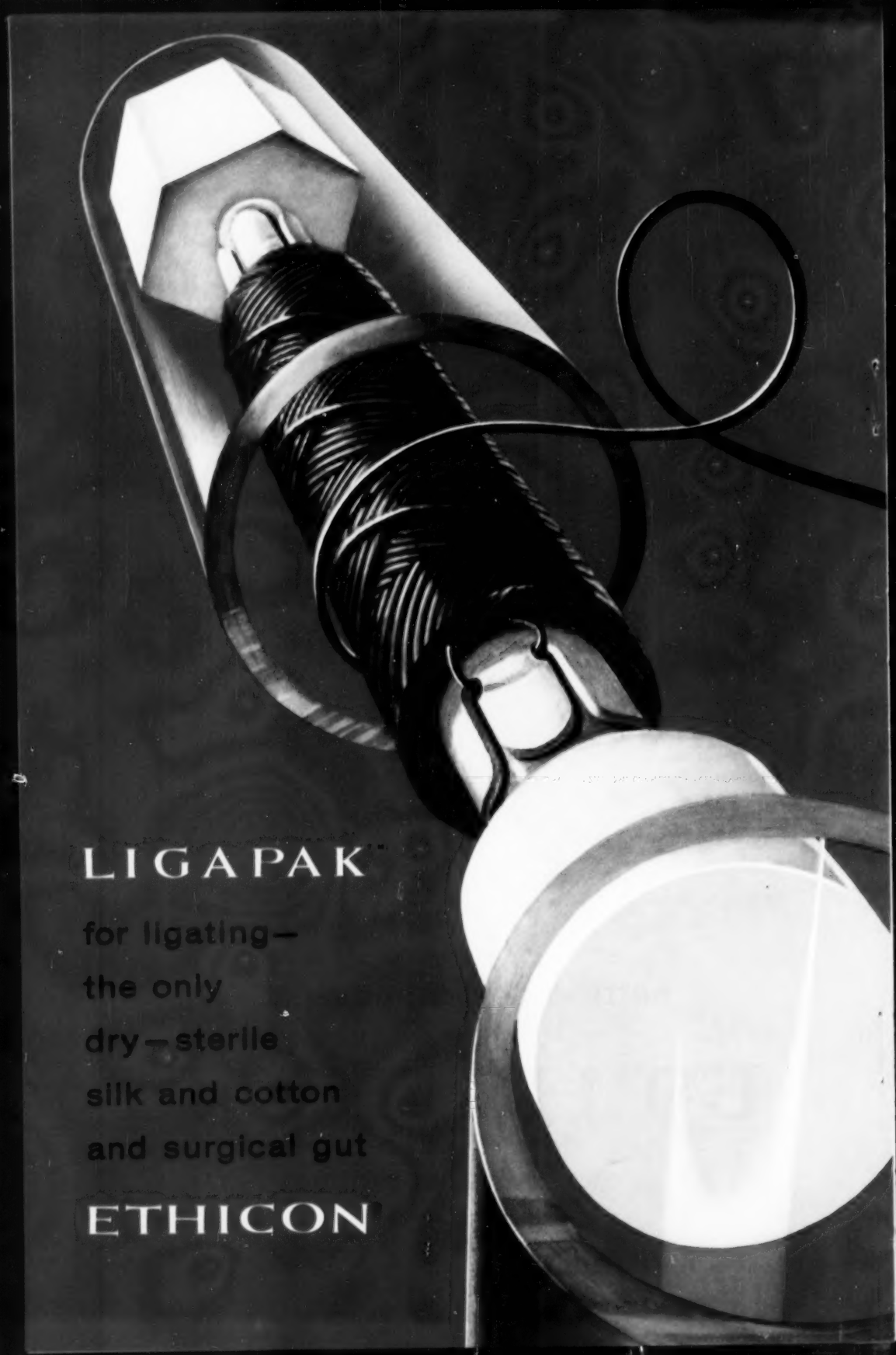
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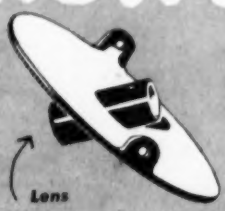

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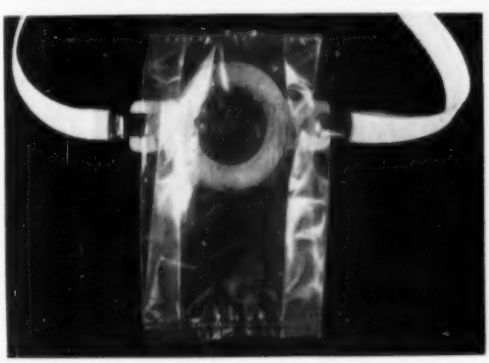

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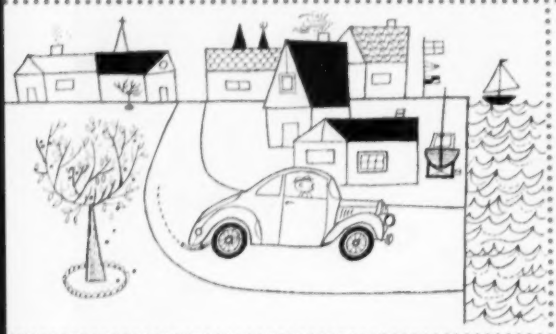

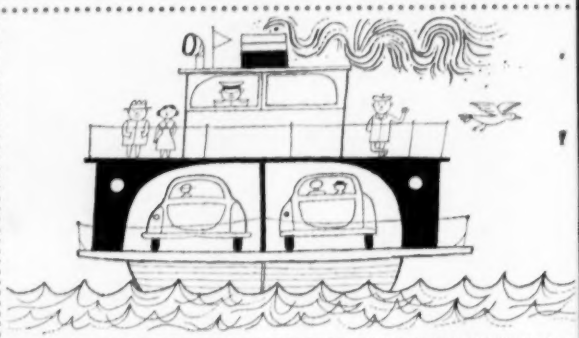

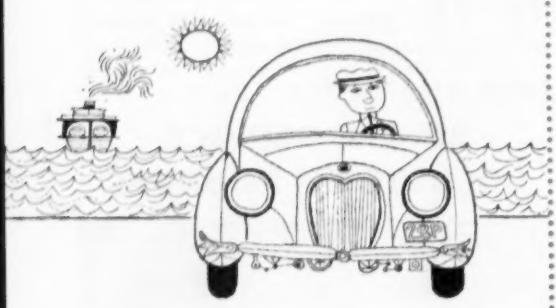

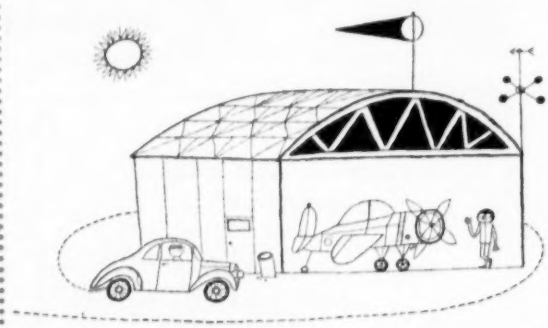

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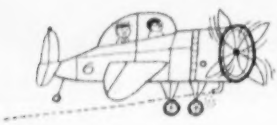

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Perspective

HERBERT H. DAVIS, M.D., Omaha

Forty years ago, at the twenty-fourth annual meeting of this Association, my father prefaced his Presidential Address with the words: "I wish to take this opportunity to thank the Association for the honor conferred upon me, and to express to you my appreciation. I know of no higher honor that could come to a surgeon than to preside over such an Association as this." I can think of no better words to express my own feelings on this occasion. To them I would add my thanks to the able officers and the members of the local Committee of Arrangements, who have made my duties easy, and to all the members of the Association who have contributed to the stimulating discussions within the meetings and in small groups.

In preparing my remarks for this occasion, I turned to my father's Presidential Address to reflect on the progress made in the profession during the past forty years, so eventful in the history of surgery. He presented a strong appeal that his audience advocate a standardized surgical training and that they strive for "teamwork" between themselves as surgeons and those specialists who could aid them to reach accurate diagnoses. In the intervening years we have achieved those objectives and many more that my father could hardly have foreseen. Indeed the progress in surgical science has been staggering. In his internship there were only three abdominal operations, two of which turned out fatally, and that was about the usual risk. To-day, as I need hardly tell you gentlemen, there is no part of the body that is not amenable to surgical therapy.

Progress in medical science and medical training has been especially marked in our own nation. The center of medical research and teaching has moved from Europe to the United States, and whereas my father went to Berlin for surgical training and I went to Vienna, my son has—for obvious reasons—received all his training here. Our residency training programs have developed a large number of highly trained specialists; the research problems in our medical colleges are receiving more and more attention. And as a result the American people today receive the most capable medical care of any people at any time in any part of the world.

Yet despite all these forward strides, we hear rumblings of dissatisfaction from the American public. They seem to have lost the confidence which they once had in the medical profession; they bemoan the passing of the general practitioner who, with all his limitations, was a friend and counselor of his patients. With medical and surgical costs constantly rising, they are prone to accuse the profession of selfish motives, and no amount of statistical information about rising salaries and cost of supplies will reassure them. Moreover, they have other complaints. The modern specialist, they claim, is aloof, hard to talk things over with, hard to reach when he is urgently needed. He keeps an office full of patients waiting too long, they think, and to them he seems more interested in evaluating laboratory tests than in listening to and understanding their problems. He seems reluctant to make house calls during the day, and he is virtually unavailable in the long hours of the night, when an ailing person most needs solace. What, the public asks, has become of the tradition of selfless devotion for which the medical pro-

Presidential address read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

fession has won its honorable position in society? Are doctors today more concerned about their own convenience than about their patients' welfare?

Now you know and I know that many of these complaints are groundless. We know, for example, that a well-chosen series of laboratory tests will often tell more about a patient's condition than any amount of questioning or pulse-taking. But we also know that we are dealing with people who are not, for the moment at least, completely rational—people whose bodies are ailing, whose minds are troubled, whose emotions are tense. They want reassurance; they want kindliness and understanding, and so do their families. They want to feel that they can look to us with complete confidence, with that kind of uncritical trust which their grandfathers felt for the family doctor.

How, then, have we failed them? In my father's plea for standardization of surgical training he made a few incidental observations which I think worth repeating. "The would-be surgeon," he declared, "should be a man who loves life, and has the highest regard for the life of his fellow. He must be willing to do his utmost for every case entrusted to his care. He must be warm-hearted, have wide sympathy, and be . . . devoted to his profession. . . ." Now these, as I say, were incidental observations; he was describing what we might call the prerequisites of the trainee for surgical practice. He did not bother to develop his points; he accepted them as axiomatic because they seemed perfectly obvious. But, I would ask, have we, in our eagerness to perfect medical training, forgotten the axioms on which such training should be based? In other words, do we need to reconsider our notions of what constitutes the ideal training for a prospective member of our profession?

Most young men who enter medicine do so because of a vague idealistic desire to help their fellow man, directly as practicing physicians or indirectly as research specialists. Certainly that desire is not to be scorned; it needs, rather, to be strengthened and clarified by exposure to the best that has been known and thought in the world. Let me quote my father once more: "The wider the culture preceding the beginning of the work of the medical college, the better the average results." Again he did not pause to develop his statement or offer proof for it; he assumed that his audience needed no proof. Yet as medical science has become more complex, too many medical schools have demanded that entering students have more and more specialized training as undergraduates and, since time is necessarily limited, they have emerged with less and less of a broad cultural education. Some medical schools have already begun to reverse the trend; they have urged that prospective students study economics, sociology, psychology, and, especially, history, philosophy, and literature, that they learn to understand the mind of their fellow man before they attempt to minister to his body. Too often in charity hospitals and elsewhere in their training they will see man at his worst, and they need to have ever before them a clear conception of man at his best—of the noblest products of his mind and imagination—if they are to retain the ideals which attracted them to the profession.

Let us, I urge, have ever more of this kind of preparation for medical studies. For though the teacher in the first year of medical school may delight in the young man who has excelled in zoology, chemistry, and physics, the patient to be healed will probably prefer the man who reveals wisdom and understanding.

Of course these remarks about undergraduate education presuppose that the young man's earlier training has been such as to encourage fine ideals. Liberal education can do a good deal, but it can rarely make an honorable man out of a scoundrel. And medical schools need not only the cultured man but the honorable man with noble instincts drilled into him by wise and loving parents. To choose such men from the hordes of applicants, medical school faculties should rely on more than mere grades. They should insist on personal interviews with candidates in an attempt to cull out the

brilliant but unscrupulous few. I do not, of course, mean to imply that we should ignore grades or ability in selecting students, but I believe that we should bear ever in mind that our profession is a sacred one which needs men of strong character and high ideals as well as brilliant minds.

And what of the task of the medical schools themselves? Certainly they should continue to teach the science of medicine, but they should also strive to continue the process of character-molding. Training should be based on the fundamental principle that the function of the medical profession is the care of the sick. We tend too much today, I believe, to make scholarship our goal and to direct our training toward the development of research workers. Such workers are surely essential to the progress of our profession; yet the fact remains that most of the products of our medical schools will devote their energies primarily to the care of human beings. To prepare good doctors, our faculties must be well balanced to expose the student to brilliant research minds, extraordinary lecturers, diagnosticians, and therapists, and also to kindly, friendly teachers who can convey to the student the important lesson of understanding his patients. Let us always remember that the famous man is not always the best teacher. In fact, the research man is often a poor teacher of medical students, partly because he is not interested in teaching and partly because he may talk over their heads. It is a waste of time for this man and for his students to require him to do routine teaching. He is of great importance to his school in making new discoveries, in interesting and directing students and doctors in research, and in attracting fine new research men to the school. But research and teaching need not always be coupled. And just as all research men should not be required to teach, so all teachers should not be required to do research. Research is invaluable in stimulating original ideas, constructive thought, thoroughness, resourcefulness, discernment in reading medical literature, and judgment in the acceptance of new ideas, and all these help to develop logical thought, which the student will need if he is to be an effective citizen and a competent physician. But the professor who prefers teaching to research may impart values no less important that these.

True, someone may remark, but those values are innate; they cannot be taught. By the time a man enters medical school his character is formed, and no mouthing of noble ideals will alter it. To that claim I would present some objections; for though the entering medical student may be an adult in human affairs, he is a mere infant in medical affairs. There are certain things which most of us have learned the hard way, but which could easily be taught. Take, for example, so elementary a matter as finances. Most young doctors enter upon their practice with little or no idea of how much to charge for their services, how to keep books, or how to collect fees, and a few talks in medical school from an experienced doctor could help them immeasurably in solving some of these basic questions. And how, you ask, would such information contribute to strengthening character? I answer quite simply that the young doctor prepared to cope with these initial problems of the profession will be spared uncertainty and embarrassment and will enter upon his practice with a firmer confidence in himself. And surely such a man will have a better chance of inspiring confidence in his patients.

There are innumerable other procedures which the neophyte physician must usually learn from experience and which he could easily be taught in advance. He needs to be told about his responsibilities to his community, his obligations to charitable enterprises. Such matters may have much to do with his acceptance in the community, which, in turn, will develop in him healthy attitudes that may have an important bearing on his eventual success in his profession. He should be taught to spend a patient's money as he would his own. And just as we make students record the cost of the laboratory procedures which they order so as to make

them cost-conscious, so we should teach them to hold down cost for a patient by avoiding unnecessarily long hospital stays, choosing the cheaper of two equally effective drugs, or keeping laboratory tests to a minimum by determining the indication by means of a careful history and physical examination. In short, medical students could and should be taught the proper balance between science and thrift.

Similarly, they need to be instructed about certain fundamentals of their relationships with other physicians. The young doctor needs to know what to expect of a consultant or what to tell the patient before calling a consultant. And he needs a host of other bits of information—about the principles of medical ethics, the legal requirements and pitfalls of medical practice, and, above all, the importance of kindness and understanding in dealing with patients and their families, or the value of an occasional extra call to allay their fears.

Basically what I am appealing for, obviously, is a course in, or at least a series of talks about, public relations for medical students. Businesses spend huge sums of money in public relations; surely we can afford to spend a few hours of our students' time. For this is public relations at its highest level, based on the Golden Rule. Sound home training and liberal education should turn out the well-rounded, humane man. But he may still need some direction before he emerges as a well-rounded, humane doctor, the doctor who has confidence in himself and inspires it in others, who realizes that the most important person in the operating room is the patient, and who treats his patient as he himself would be treated.

And while we advocate such preparation for our students, let us be sure that we who have learned these principles from experience set a proper example. Let us too apply the Golden Rule in our treatment of patients; let us be loyal to the ideals of our high calling and to our responsibilities as citizens. The physician or surgeon who is a well-balanced man, trained in the science of medicine, and eager to serve his patients and his community is the glory of his profession. He is loved, respected, and demanded, and he brings respect to all doctors.

Let such men remember that, despite the many demands on their time, they should play an active part in directing medical policies. As a democracy is no better than the people demand it be, so are organized medical programs and societies no better than physicians demand that they be. If the intelligent, conscientious, and industrious citizens take little interest in government, the democracy is poorly managed. If the finest physicians who are in constant contact with their patients take little interest in organized medicine, we shall never regain the understanding and respect which we seem to have lost. These men should find time to help in inspecting hospitals and medical schools, in making plans for closer relationships between organized medicine and the public. Of course many of our finest doctors do so; I would plead, however, that all physicians consider such responsibilities as a duty to the profession. The profession should lead the way to better understanding with the public and not lag behind their just demands. As for the small number of selfish, dishonest, or ignorant physicians responsible for most of the public distrust of the profession, means should be found to deal with them as they deserve.

I remarked earlier that in the days of the general practitioner the physician was regarded with uncritical trust. Now, despite extraordinary progress in scientific medicine, he is too often regarded with uncritical distrust. But if we will never forget to exercise our skill, friendliness, kindness, thoughtfulness, interest, and integrity, if we will instill these ideals in our students and foster them in our organizational programs, we can remove this distrust, and for it we can substitute what we hope to be judged by—critical trust.

Surgical Lesions of Coccidioidomycosis

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Human coccidioidomycosis is a disease resulting from infection by the fungus Coccidioides immitis. This disease is endemic in the southwestern United States, northern Mexico, Argentina, and Uruguay. There is an increasing number of cases reported from the various areas in our country outside of the southwest. Most of these have had a history of visiting the southwestern section of the United States previous to the onset of their disease. Since travel to the southwest is common and on the increase and because the disease is usually considered a rarity by those living away from the endemic areas, it was thought that it would be of interest to present some of the features of the disease as well as review the related surgical problems. It should be emphasized that coccidioidal infection may appear in any individual who has been exposed to the fungus while in the southwestern portion of the United States, regardless of the length of time spent in this locale.

Coccidioidomycosis is usually acquired by inhaling the chlamydospores of the fungus which are carried in dust. Entry can occasionally occur through abrasions or lacerations. Infection by ingestion does not occur. The incubation period varies from one to three weeks. After the chlamydospores have entered the human host, usually lodging in the lung, they round into spherules and divide into segments which develop into the characteristic endospores with a double-refractive wall. The fungus spreads in the host by rupture of the spherule wall, releasing the endospores which grow into mature spherules (Fig 1). These may be carried by the blood or the lymphatics to distant organs, disseminating the disease.

The various phases of the disease have been classified as the initial or primary infection, which is usually self-limited to the lung area, or the progressive secondary disseminated infection, often fatal, which apparently results from a coccidioidal septicemia, affecting numerous portions of the body with coccidioidal granulomatous lesions.[1] The most frequent sites of localization are, in the following order: the lungs, the lymph nodes, the spleen, the skin and subcutaneous tissues, the liver, the kidney, and the bones.[2] From study of some of the cases we are reporting, it seems that a third category should be added to the clinicopathological forms. This probably should be termed the tertiary phase of coccidioidomycosis, as these lesions of localization are usually singular and cannot be classified in the primary or secondary stages which are so universally used in the literature. It seems reasonable to assume that these cases we have studied have gone through a primary and secondary (disseminated) stage, the fungus finally localizing in one or more of the viscera. Probably host resistance prevented the secondary stage from becoming fatal; yet the fungus retained sufficient virility to localize in the various areas and to cause persisting symptoms.

In the great majority of primary cases, the disease is mild and the chest lesions are too minute to detect roentgenologically. In the less frequent but more severe infections,

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pleural effusion and pneumonitis with hilar adenopathy are demonstrable. The infection is usually walled off and undergoes fibrosis and often calcification. Occasionally, necrosis in a pulmonary coccidioidal lesion will produce a cavity. Usually these will close spontaneously, but some do persist, usually being single and thin-walled. These cyst-like cavitations are "silent" for the most part, except for occasional hemoptysis, and it is rare that the lesion progresses or spreads, being dissimilar to tuberculosis or disseminating coccidioidomycosis. Occasionally, spontaneous pneumothorax occurs secondary to a bronchopleural fistula.

In the primary cases, only 40% of coccidioidal infections are accompanied by symptoms. The commonest of these are fever, pleurisy, malaise, arthralgia, anorexia, and night sweats. Five per cent of the infections in the white male and over 20% of the infections in the white female are accompanied by erythema nodosum or erythema multiforme.

The progressive secondary or disseminating coccidioidal infection is that type of the disease which has been recognized for over 45 years and was the only known form of the disease until Gifford and Dickson * recognized that most illnesses caused by C. immitis were benign and self-limited. Army studies [5] have indicated that approximately 1 in 400 coccidioidal infections in white males disseminated. There is a racial susceptibility to the progressive disease, and dissemination occurs in a ratio of 1 to 100 in infected Negro males. Dissemination is rare in the white female except when the infection is acquired during the third trimester of pregnancy. Dissemination usually occurs within a few months of the primary infection. A pulmonary lesion may not have been present or, frequently, has regressed so that the pulmonary roentgenogram is within normal limits when dissemination is diagnosed. It is believed that the original attack of primary infection confers immunity against subsequent infections.

The suspicion of coccidioidomycosis is aroused by the patient's history, but the diagnosis must be confirmed by laboratory evidence. The most useful procedure is the coccidioidin skin test. The complement-fixation test is also of diagnostic aid in the later and more severe infections. Microscopic and culture studies furnish the most complete and incontrovertible proof of the disease. In accessible lesions in which biopsy can be done, the microscopic picture is definite, allowing the diagnosis to be made without doubt. A number of reports of coexisting coccidioidomycosis and tuberculosis have appeared in the literature.[6]

The large majority of infections caused by C. immitis are self-limited and are not seen by surgeons, the treatment being symptomatic. In the rarer cases, the infection progresses, causing disability that demands sur-

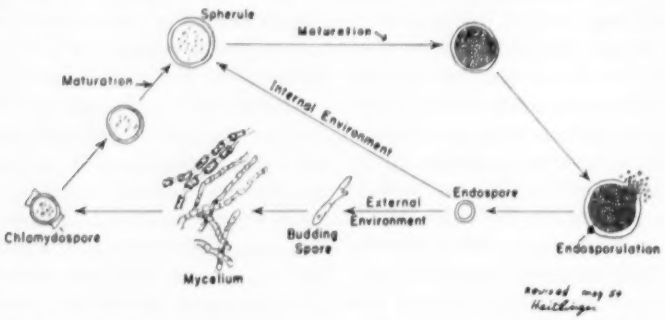


Fig. 1.—Schematic illustration demonstrating life cycle of coccidioides immitus (redrawn from Forbus and Bestebreurtje, in *The Military Surgeon*, November, 1946 [no. 5, Vol. 99, p. 659], publisher, Army Medical Museum, Washington 25, D. C.).

* References 3 and 4.

gical intervention. Thus far, no specific form of therapy has been proved, the known chemotherapeutic agents or antibiotic drugs being ineffective for a cure.

Chest lesions are the commonest foci of the disease which need surgical treatment. The indications for surgical intervention in pulmonary coccidioides infections are becoming more standardized, but it is our feeling that some of the reports in the literature have indicated a too radical approach and that some lesions which have been removed by operation would have healed on conservative therapy. There seems to be little tendency towards dissemination or local spread from the pulmonary infections with associated chronic lung cavities.

The indications for surgical treatment of pulmonary coccidioidomycosis which seem generally to be acceptable are as follows: (1) spontaneous pneumothorax with a nonexpansible lung, (2) gross hemoptysis in the presence of a persistent cavity, (3) solid tumor of the lung in older persons that cannot be definitely diagnosed as coccidioidomycosis, and (4) a large, blocked, or expanding cavity.

Segmental resection, lobectomy, or decortication are the usual procedures done for surgical cure, depending upon the indications for the operation and the extent of the complications. The following case report illustrates certain points of interest in the surgical attack of pulmonary coccidioidomycosis.

A white woman, 44 years of age, entered the hospital on Dec. 6, 1953, complaining of hemoptysis, fever, and pain in the left chest. She was a known diabetic but had been well controlled. She had lived in Arizona for over two years, and her symptoms had their onset about one year previous to hospital admission. Before entrance to the hospital, x-rays demonstrated a large cavity of the left upper lobe and the diagnosis of coccidioidomycosis had been confirmed by coccidioidal serological studies (Fig. 2). A left upper lobectomy was done on Dec. 10, 1953. The microscopic diagnosis was pulmonary coccidioidomycosis with cavitation. The patient made good postoperative progress and was discharged from the hospital on Dec. 20, 1953. Shortly after her dismissal, the patient again noted hemoptysis and x-ray studies showed evidence of a bronchopleural fistula, manifested by a localized

Fig. 2.—Roentgenogram showing coccidioidal lung abscess.

air space in the left hilar area. The patient was readmitted to the hospital on Feb. 8, 1954. On exploration, a localized empyema pocket was found about the upper bronchial stump but no definite fistula could be demonstrated at that time. Therefore, the space was drained with a catheter and a limited thoracoplasty was done. After this, the patient has apparently recovered, having no further symptoms from her disease. It is assumed that the bronchus adjoining the resected lobe was involved by coccidioidal granulomas, accounting for lack of healing of the stump and accompanying bronchopleural fistula. Unfortunately, the specimen was sent away for photographing before a section of the bronchus had been made.

The incidence of bronchopleural fistula following segmental resection or lobectomy for this disease is probably higher than is known. This may be due to coccidioidal infection of the bronchus adjoining the cavity, which does not heal as normal tissue postoperatively. Melick states that bronchial involvement is not too uncommon in coccidioidal infections. Several cases of bronchopleural fistula following excisional surgery with bronchial infection are known to have occurred.†

† Melick, D. W.: Personal communication to the authors. O'Hare, J.: Personal communication to the authors.

It seems logical to recommend that an examination be made of the bronchial stump at the time of excisional surgery, and, if a coccidioidal infection is found in the bronchus, a limited thoracoplasty should possibly be done at the time of the primary operation in cases of upper lung lesions.

In a nation-wide survey of 101 cases of pulmonary coccidioidomycosis in which excisional surgery was done, the mortality and morbidity rate was low, the complications being bronchopleural fistula, recavitation, and empyema.[7]

Coccidioidal infections in extrapulmonary viscera, while common in the disseminated form, are rare otherwise and represent residual infection after disseminated coccidioidomycosis has stabilized itself. In this category, bone lesions are probably the commonest in those patients who have survived the period of dissemination. These lesions are of serious nature. Amputations of peripheral extremities have been required in a number of cases, owing to osseous fistulas, pain, deformity, and disability. Immobilization, rest, and occasional incision and drainage is at present the treatment of choice in coccidioidomycotic bone lesions, until a specific chemotherapeutic agent is discovered.

The types of lesions found in bone are the following:

(1) unilocular and multilocular cysts with little surrounding reaction which may be associated with soft tissue abscesses

(2) Marginal erosion with cortex destruction and periosteal bone formation

(3) lesions resembling osteomyelitis occurring most frequently in the shafts of the bones of the hands and feet, with diaphyseal destruction and periosteal new bone formation; these usually do not sequestrate as do those of typical osteomyelitis.

(4) joint involvement, which may be purely synovial or associated with subarticular destruction indistinguishable on x-ray from tuberculosis

(5) coccidioidal osteomyelitis with sequestration (rare).

A Negro man, aged 33, was admitted to the hospital on Oct. 2, 1951, with a tentative diagnosis of bone tuberculosis, complaining of pain and multiple draining sinuses of the left wrist and pain and swelling of the left knee. He had been hospitalized in 1943 for the first time, when the tentative diagnosis of tuberculosis of the left wrist and knee had been made. Since that time he had had a number of hospital admissions both in Arizona and in California. These were only for short periods of time, owing to his habit of signing a release after being hospitalized for several days. Smears made in 1944 and 1946 from the draining sinuses of the wrist were negative for specific infection. In 1946, a resection of the distal end of the left ulna was done. The patient stated that this was for a "tumor," but the exact diagnosis was not learned. Shortly after the present admission a coccidioidal skin test gave a 2+ reaction with 1:100 dilution in 48 hours. His sedimentation rate (Westergren) was 142 mm. in an hour. The complement-fixation test for coccidioidomycosis was 4+ at a 1:256 dilution, and the precipitin coccidioidin test was 3+ at a 1:40 dilution. Blood cultures were negative. Chest x-rays showed no currently active pulmonary disease. X-rays of the left wrist showed destruction at the distal end of the radius and of several carpal bones, considerable destruction of the articular cartilage with joint effusion, and displacement of the pisiform bone. X-ray diagnosis was residual coccidioidal osteomyelitis. A-P and lateral x-rays of the left knee showed narrowing of the lateral cartilage space without evidence of bone destruction associated with diffuse swelling of the joint. The patient was cachectic, running a daily septic temperature, and manifested continual pain in the left wrist and knee. Conservative therapy was instituted with antibiotics and immobilization of the left wrist and knee. Owing to pro-

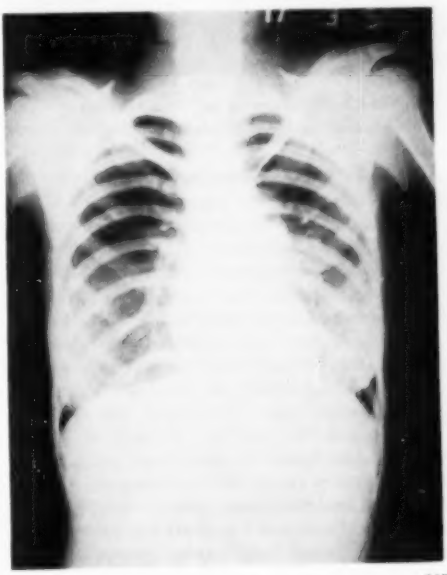
Fig. 3.—Roentgenogram showing coccidioidal osteomyelitis of the carpal bones and distal end of the radius.

Fig. 4.—X-ray of knee joint demonstrating coccidioidal osteomyelitis and arthritis.

gressive bone necrosis, increasing pain, and persisting daily elevation of temperature, an amputation was done of the left hand and wrist on Feb. 20, 1952 (Fig. 3). Examination of the amputated specimen showed coccidioidal bone infection. On March 14, 1952, the patient attempted suicide, owing to pain in his left knee. He continued to have a septic temperature, and more redness, swelling, and fluctuation of the left knee joint developed. X-rays showed a progressive destructive process of the knee joint cartilages, and on March 25, 1952, an incision and drainage of the knee joint was done, with immobilization in plaster splints. A culture of the drained material showed C. immitis on Sabouraud's media. The knee joint continued to drain, and the patient was given but little relief from his pain. In April, 1952, there were areas of bone destruction obvious in the medial tibial condyle, with subluxation of the joint and generalized demineralization of the bones in this area (Fig. 4). On July 24, 1952, a midthigh amputation was done of the left leg. The patient's condition improved rapidly. He gained weight; his temperature returned to normal, and his pain was entirely relieved. The flaps over the stump, however, failed to heal completely, leaving a raw area over the end of the stump. An attempt to cover this area with a skin graft was done on Oct. 6, 1952. Only 15% of the grafted skin remained viable. The patient was almost clinically well and was mobile in a wheelchair, and arrangements were being made through the social service department to discharge him from the hospital. This he resented. On Dec. 22, 1952, he obtained a revolver and shot a social service worker and a nurse and committed suicide.

A Negro girl, aged 16 years, reentered the hospital on April 25, 1952, complaining of pain and swelling of the left knee with inability to extend the knee. These symptoms had been present for about two months. She had repeatedly been a patient in the hospital since June, 1951. At the time of her first admission she had had a daily elevation of temperature, a butterfly-shaped skin lesion over her nose, and generalized macular skin rash. She later developed splenomegaly, leukopenia, anemia, and albuminuria. X-rays taken in November, 1951, showed a perihilar pneumonitis with left hilar adenopathy (Fig. 5). The x-ray diagnosis at this time was coccidioidomycosis or tuberculous adenopathy. The coccidioidin skin test was negative. An aspiration was done of the left knee joint on March 28, 1952, and a culture on ordinary media and a smear showed no organisms. At this time, a coccidioidin skin test showed 1+ infection at a 1:10 dilution. A bivalve leg cast was applied, and on May 15, 1952, an ulcerated area was observed overlying the tibial tubercle, draining sanguinous purulent material. X-rays on May 9, 1952, revealed an abscess of the upper left tibia with demineralization of the femoral condyle and patella. On May 16, 1952, a curettement and open drainage of the tibial abscess was done. Microscopic studies showed coccidioidal infection. After this, the patient's condition improved. There

Fig. 5.—Lung x-ray showing fairly typical lesion of pulmonary coccidioidomycosis.



was drainage from the osteomyelitis for a long period, but follow-up x-rays at intervals showed progressive healing and a filling-in of the abscess cavity (Figs. 6 *A* and *B*). For the past year, the drainage has ceased, and at present she appears clinically well.

A Negro woman, aged 26 years, entered the hospital on Oct. 8, 1946, complaining of pain in the lumbar region, especially on the left, and persistent drainage from a left supraclavicular lymph gland that had been present for the previous 11 months. This patient had been injured in an automobile accident in 1945, and x-rays taken of the spine at that time showed an inflammatory involvement of the first lumbar vertebra. She stated that she had noted numerous masses appearing over the neck, arms, back, and inguinal regions for the past year which would slough and drain, ultimately healing. Physical examination showed numerous scars over the skin surface and a draining sinus at the lower portion of the left neck in the supraclavicular area. At the left costovertebral angle was an apricot-sized fluctuant area which was tender on palpation. Lymph glands in the axilla, groin, and cervical regions were all enlarged. Blood cultures were negative. Studies for the acid-fast bacilli were negative. Secondary anemia was present. Her serology was negative, and her urine was normal. X-rays of the chest were normal. X-rays of the spine (Fig. 7) showed that at the left lateral aspect of the first lumbar body was an area of increased bone density, and the appearance of the vertebral body strongly suggested the possibility of a low-grade process, "perhaps tuberclosis," with marked change of the space margins and calcifications at the margins of the disc. The lymph gland in the left supraclavicular area was removed. Laboratory examination showed this to be a coccidioidal infection. She was discharged unimproved on Oct. 22, 1946. She was again readmitted on Nov. 17, 1946, with increased pain and swelling in the left costovertebral angle. An abscess was incised and drained in this area, and a biopsy of the wall showed coccidioidal infection. Her complement-fixation test showed 4+ reaction in a dilution 1:64, which confirmed the diagnosis of disseminated coccidioidal infection, indicating a poor prognosis. The patient, however, is still living and stabilized without drainage from the infected lumbar vertebra and is comfortable as long as she wears a back support.

Fig. 6*A*.—Roentgenogram demonstrating coccidioidal abscess of upper left tibia.

Fig. 6*B*.—Demonstrating healing of bone abscess after curettement and open drainage.

Tuberculosis and coccidioidomycosis can appear in the same bone, confusing the diagnosis.[8] Monoarticular coccidioidal arthritis has been reported[9] as well as coccidioidal tenosynovitis[10] and should be included with the lesions of the skeletal system.

There have been very few residual lesions of C. immitis occurring in areas other than lungs or the osseous structures reported in

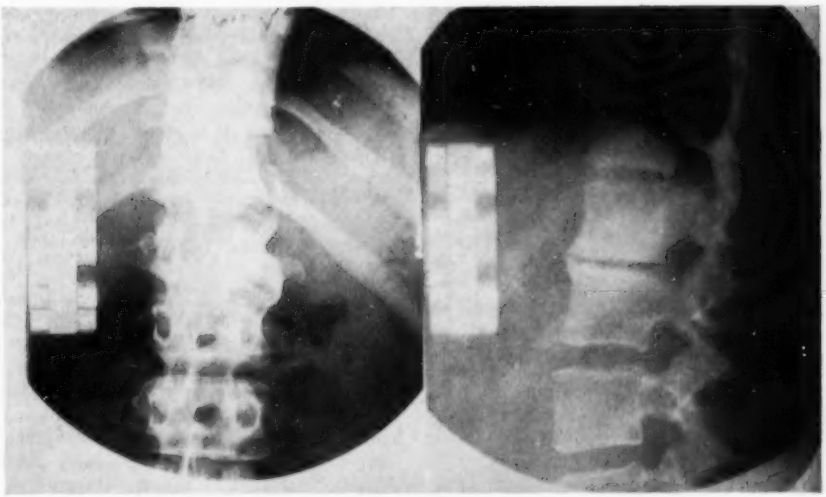


Fig. 7.—Healing coccidioidal osteomyelitis of vertebra as shown by x-rays.

the literature. These lesions are rare and, like bone lesions, represent the tertiary stage of coccidioidomycosis, figuratively being the ashes following the fire of dissemination.

The following cases are presented to show that such cases do occur, although they are unusual.

A 23-year-old Negro woman entered the hospital on April 9, 1949, complaining of dysmenorrhea, postmenstrual pelvic pain, and profuse vaginal discharge.[11] These symptoms had been present for about one year. Eighteen months previous to her hospitalization she had fallen into a pile of dust and sagebrush. Shortly after this, the patient developed large masses in the cervical region and an enlarged mass over the lateral left malleolus. Several of these tumors had been drained, and some had opened spontaneously. X-rays of the chest taken on hospital admission were normal. Physical examination showed a fluctuant tender mass in the posterior pelvis which seemed fixed. At operation, on April 11, 1949, a pelvic mass was found adherent to the omentum and small intestines and was identified as a left tubo-ovarian abscess. This was removed without rupture. The patient had an immediate smooth postoperative course. Microscopic examination of the tissue showed a C. immitis infection (Fig. 8). Postoperatively no fistula formation developed, but the patient was readmitted to the hospital in nine months and died of coccidioidal meningitis.

In three cases of coccidiodal infection of the pelvic organs that have been reported in the literature, only two patients have recovered.‡

A white woman, aged 29 years, entered the hospital May 30, 1943, complaining of pain in the right lower quadrant and right renal region with radiation into the groin, severe cough, fever, weight loss, and constipation. The patient had been chronically ill for the past two years but during the two months before admission had been bedfast with a daily elevation of temperature over 100 F and had lost 15 lb. (6.75 kg.). Chest x-rays had shown a soft infiltration of the lung behind the chondral junction of the first left rib. There was bilateral perihilar exaggeration, and there were many minute calcifications in each hilar region. Laboratory studies revealed a negative agglutination for undulant fever; negative serology; red blood cell count 3,990,000; hemoglobin 11 gm.; leucocytes 10,550; 5% stab cells; 76% segmented cells; 19% lymphocytes; sedimentation rate was 94 mm. in 60 minutes (Westergren), and urine analysis was negative. A barium enema and gastrointestinal x-ray series showed only hypermotility of the proximal gastrointestinal tract and moderate visceroptosis. A retrograve pyelogram was essentially normal except for increased tissue density in the region of the right psoas muscle. The physical examination showed tenderness in the right lower quadrant and normal pelvis. It was noted that the patient flexed the right leg while in the decubitus position for comfort. On standing, the patient leaned her body to the right. An exploratory operation of the abdomen was done on June 21, 1943, and the only

‡ References 12 and 13.

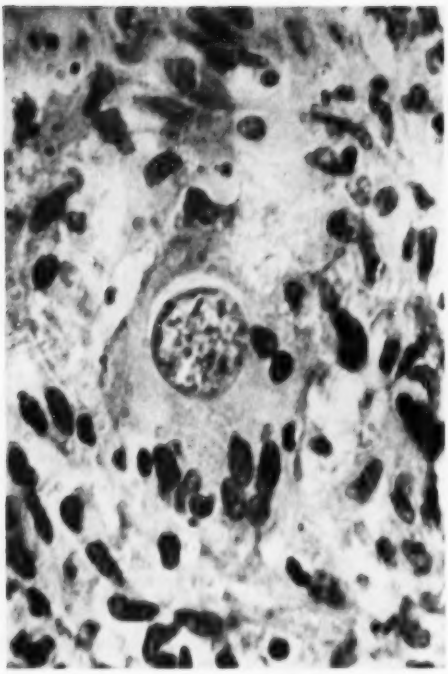


Fig. 8.—Photomicrograph showing a typical endosphore of coccidioides immitus with the double refractile wall containing spheroid bodies.

abnormality found was some thickening of the right iliopsoas muscle, but no abscess could be found to explain the clinical symptoms. Postoperatively, the patient did not improve, continued to run fever, and noted increasing pain in the right renal and abdominal areas. She was reoperated upon on Sept. 24, 1943, through a lumbar incision, and perinephric abscess was drained. A second incision was made in the right inguinal area, allowing proximal and distal drainage. Curettings of the granulomatous tissue showed coccidioidal infection. The patient gradually improved, completely healed, and has remained well.

A white man, aged 32, entered the hospital May 24, 1947, complaining of chest pain, low-grade fever, and lethargy of several weeks' duration. He had a past history of being hospitalized in the midwest for glandular tuberculosis, with neck, hilar, and inguinal gland involvement. Recovery had apparently been complete. Coccidioidin skin tests were positive in 48 hours (1:100 dilution). His sedimentation rate (Westergren) rose from 4 mm. in May to 42 mm. in June. X-rays showed hilar adenopathy and a ground-glass appearance suggestive of coccidioidomycosis. The patient developed tender lymph nodes in the right inguinal region and the left posterior cervical chain while hospitalized. This was believed to clearly indicate a coccidioidomycosis dissemination. He improved and was discharged from the hospital on June 27, 1947. He continued to rest at home, but owing to a granulomatous lesion which developed in the right knee, about 2 cm. in diameter, he was readmitted on July 21, 1947. The lesion was excised, and a primary skin closure resulted in healing. After this the patient completely recovered. Microscopic examination of the lesion excised from the wound showed coccidioidal granuloma.

A white woman, aged 51, entered the hospital on June 7, 1950, for the treatment of asthma and recurrent attacks of left pyelonephritis. Genitourinary symptoms had been present intermittently for the past several years associated with fever, headaches, and pain in the left lumbar region. These episodes had been treated symptomatically until May 29, 1950, when retrograde pyelograms were made (Fig. 9). These showed a soft tissue mass on the anterior lateral aspect of the left kidney suggesting the presence of a kidney cyst. A second area of abnormality was seen in the lower pole of the left kidney. There the posterior calyx was incompletely filled and ragged in contour and suggested the possibility of a chronic infection such as tuberculosis. The patient had previously shown a positive coccidioidin skin test with negative serological tests for coccidioidomycosis. Urinary studies during hospitalization showed a negative culture for acid-fast bacilli, specific gravity of 1.008, a trace of albumin, 20 to 30

Fig. 9.—Retrograde pyleogram showing renal cyst and coccidioidal abscess of left kidney.

white blood cells per high-power field, and 5 to 8 red blood cells per high-power field. A diagnosis of tuberculosis of the left kidney was made preoperatively, and, on June 9, 1950, a left nephrectomy was done. A congenital cyst of the kidney was found. In the lower pole, extending from the pelvis into the posterior surface of the kidney, was a cystic area containing caseous material measuring 2 cm. in width. Microscopic studies of the caseous area showed numerous spheroid bodies with sharply defined walls contained in an inflammatory reaction composed of plasma cells and lymphocytes typical of a coccidioidal granuloma. No acid-fast bacilli were found. The patient left the hospital on June 21, 1950. Since this time, she has remained well.

A Mexican man, aged 43, entered the hospital on Sept. 17, 1950, for the treatment of a wart-like growth on the lateral aspect of the right ankle. This lesion had had its onset about nine months previously, and was about 3 in. (7.5 cm.) in diameter, and in the surrounding skin were several wart-like lesions. X-rays of the chest on admission showed "a well defined density measuring 5 cm. by 2 cm. within the right upper interspaces in association with considerable pleural thickening over the right upper lobe." The impression was that it represented a residue of a past granulomatous infection. X-rays of the right foot and ankle showed increase in soft tissue density but no demonstrable bone abnormality. The preoperative diagnosis was chromoblastomycosis. The lesion was removed, and microscopic sections of its base showed "circular bodies with a double refractile wall filled with some spherical bodies presenting the appearance of endospores typical of coccidioidomycosis." The patient has healed rapidly and thus far appears to be cured.

COMMENT

Human infection by C. immitis is usually a limited, mild disease. There are instances, as has been shown, when it can be a treacherous infection carrying a high morbidity and mortality. The cases presented show that the diagnosis is often not made immediately owing to the frequent bizarre symptoms and findings at the time of dissemination. In endemic areas, the diagnosis is now made much more accurately and rapidly than when many of the above cases were first seen, as we are now aware of the disease. It should be emphasized that those patients with undiagnosed disease who have been in the southwest endemic areas should have coccidioidomycosis diagnostic tests. Tuberculosis is the disease most frequently mistaken for coccidioidomycosis.

Thus far, we have little but symptomatic treatment to offer. A specific antibiotic drug is needed to save those cases with coccidioidal dissemination from death or a prolonged maiming illness.

1602 N. Norton.

DISCUSSION

DR. DAVID L. REEVES, Santa Barbara, Calif.: Mr. President, members, and guests: I would like to add one interesting feature to this problem, and that is the difficulty of neurosurgical diagnosis in chronic coccidioidal meningitis. These cases ordinarily are not diagnosed except at autopsy. Several of them have been operated on for presumed tumors of the brain and the posterior fossa. We reported one such instance several years ago in the *Journal of Neurosurgery*.

One of the last cases we saw was a woman who came in with a diagnosis of virus pneumonia and then presented symptoms of an encephalitis with pleocytosis, increased protein in the spinal fluid. She continued along for three or four months with evidence of papilledema and with no particular change in her condition. The viral studies were all negative.

Finally, we did a ventriculogram to exclude any question of an expanding lesion supratentorially, and all we found was a moderate degree of hydrocephalus, which these patients almost always show. Because we had in mind the possibility of chronic coccidioidal meningitis, we had skin tests done and agglutination tests performed, so that we would not be caught on the diagnosis. Surprisingly, those were all negative.

The patient continued living for another three or four months, and then died. Much to our surprise she had chronic coccidioidal meningitis.

It was brought out that sometimes in an overwhelming infection the various tests, particularly the skin sensitivity test and the agglutination test, will be negative, but it is another feaure to this problem that these patients do have chronic coccidioidal meningitis, and it is seldom diagnosed except at autopsy. Occasionally it is diagnosed at surgery when a piece of the dura or meninges is removed and the organism is found in the microscopic section.

REFERENCES

1. Smith, C. E.: Coccidioidomycosis, M. Clin. North America **27**:790, 1943.

2. Forbus, W. D., and Bestebreurtje, A. D.: Coccidioidomycosis, Mil. Surgeon **99**:653, 1946.

3. Gifford, M. A.: San Joaquin Fever, Annual Report Kern County Health Department, July 1, 1935, to June 30, 1936.

4. Dickson, E. C.: Valley Fever, California Med. **47**:151, 1937.

5. Smith, C. E.: Recent Progress in Pulmonary Mycotic Infections, Calif. Med. **67**:179, 1947.

6. Williams, J. J.: Syllabus on Coccidioidomycosis, U. S. A. F. School of Aviation Medicine, Randolph Air Base, July, 1953.

7. Melick, D. W.: Excisional Surgery and Pulmonary Coccidioidomycosis, J. Thoracic Surg. **20**:66, 1950.

8. Frazier, C. G.; Monroe, S. E., and O'Hare, J. E.: Coccidioidomycosis and Tuberculosis in the Same Bones, Ann. Surg. **133**:116, 1951.

9. Theimeyer, J. S., Jr.: Mono-Articular Coccidioidal Arthritis, J. Bone & Joint Surg. **36A**:387, 1954.

10. Walker, O. R., and Hall, R. H.: Coccidioidal Tenosynovitis, J. Bone & Joint Surg. **36A**:391, 1954.

11. Wormley, L. C.; Manoil, L., and Rosenthal, M.: Coccidioidomycosis of Female Adnexa, Am. J. Surg. **80**:958, 1950.

12. Jacobson, H. P.: Coccidiodal Granuloma, M. J. & Rec. **130**:424, 1929.

13. Page, E. W., and Boyers, L. M.: Coccidioidal Pelvic Inflammatory Disease, Am. J. Obst. & Gynec. **50**:212, 1945.

14. Forsee, J. H., and Perkins, R. B.: Focalized Pulmonary Coccidioidomycosis, J. A. M. A. **155**: 1223, 1954.

Osteoarthropathy in Carcinoma of the Lung

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Since the time of Hippocrates osteoarthropathy has been known to be associated with pulmonary lesions. However, little emphasis has been placed on its association with carcinoma of the lung. The fact that osteoarthropathy may be an early sign of carcinoma of the lung has been almost entirely overlooked. In this presentation we wish to show that osteoarthropathy may be the first indication of an early carcinoma of the lung and that it may precede the usual signs and symptoms, including x-ray findings, by many months. Osteoarthropathy is a sign that is easily overlooked in a routine physical examination. For that reason we feel that by drawing attention to the diagnostic possibilities, more patients with early carcinoma may be discovered before other signs and symptoms present themselves.

There have been reports in the literature of small groups of patients with carcinoma of the lung who showed osteoarthropathy. The most comprehensive review of the subject was made by Wierman, Clagett, and McDonald and appeared in the Aug. 21, 1954, issue of *The Journal of the American Medical Association*. Wierman and his associates reviewed 1024 pulmonary resections and found that osteoarthropathy had been noted in 61 instances, or 6%. They made a number of interesting observations as a result of this study. First: Simple clubbing and true periosteal proliferation are similar reactions. Second: When arthralgia, or joint pain, is present, it is practically always due to either a pleural mesothelioma or a pulmonary malignant lesion, never to tuberculosis. Third: In the carcinoma group, clubbing of the digits was present in 23 of the 25 patients and was the commonest articular manifestation. Fourth: With increasing awareness by the physician that fingernails afford valuable clues to a diagnosis, a higher over-all incidence of pulmonary osteoarthropathy will be found.

A small number of other authors have pointed out the importance of the relationship of pulmonary osteoarthropathy to carcinoma of the lung and have emphasized the fact that it may occur from 2 to 36 months before other diagnostic signs and symptoms manifest themselves. Among the other observers are Hansen, Alvarez, Craig, Van Hazel, Rasmussen, Flavel, and Pattison, Beck, and Miller.

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

TABLE 1.—*Frequency of Pulmonary Osteoarthropathy in Lung Carcinoma*

	Cases of Carcinoma of Lung, No.	Cases with Pulmonary Osteoarthropathy	
		No.	%
Wierman, Clagett, & McDonald	481	25	5.2
Hansen	100	12	12
Alvarez	47	..	..
Flavel	...	..	2

TABLE 2.—*Reported Cases in Which Pulmonary Osteoarthropathy Preceded Other Signs or Symptoms in Carcinoma of Lung*

	Cases, No.	Time Before Other Signs or Symptoms, Mo.
Wierman, Clagett, & McDonald	9	2-36
Hansen	4	....
Alvarez	12	....
Craig	4	5-10
Van Hazel	7	2-20
Rasmussen	1	16
Flavel	3	5-12
Pattison, Beck, & Miller	6	2- 8
Total	47	

Fig. 1.—Extensive clubbing of the fingers.

Fig. 2.—Right bronchogram demonstrating that the medial segmental bronchus of the right middle lobe was filled for a distance of only 2 cm., at which point there was an abrupt termination of contrast medium. The cardiac and anterior segments of the right lower lobe base appear deviated posteriorly about the probable mass immediately behind the hilus.

REPORT OF A CASE

A 47-year-old woman with adenocarcinoma of the lung in whom the only sign or symptom was that of osteoarthropathy stated that she had been in her usual state of health until six weeks prior to her hospital admission. Her symptoms started with sudden onset of painful motion of her ankles upon arising from her chair one evening after watching television. Two days later, while she was removing her nail polish, she noticed that the ends of her fingernails were "turned down." The pain and swelling of her ankles continued and spread to her knees. She consulted her physician, who thought she had arthritis and treated her with salicylates

Fig. 3.—X-ray showing periosteal changes in fingers.

and cortisone. She obtained no relief from the drugs. The swelling and pain in the joints persisted and increased without remission or migration. Also the clubbing of the fingers increased steadily and rapidly.

Her physician became alert to the unusual nature of the changes in the joints and clubbing of the fingers. He had x-rays made of the chest which were at first interpreted as being normal. The patient had no cough, sputum, hemoptysis, wheezing, or chest pain. There were no palpable lymph nodes or other evidences of carcinoma of the lung. Bronchoscopy was requested; this revealed no ulceration or tumor. There was, however, some thickening of the middle lobe carina. Bronchograms were

made which demonstrated that the medial segmental bronchus of the right middle lobe filled for only 2 cm., at which point there was an abrupt termination. The cardiac and anterior segments of the right lower lobe appeared deviated posteriorly, thus outlining a probable tumor mass (Fig. 2). X-rays of the hands, knees and ankles showed typical findings of pulmonary osteoarthropathy, including periosteal thickening (Figs. 3 and 4).

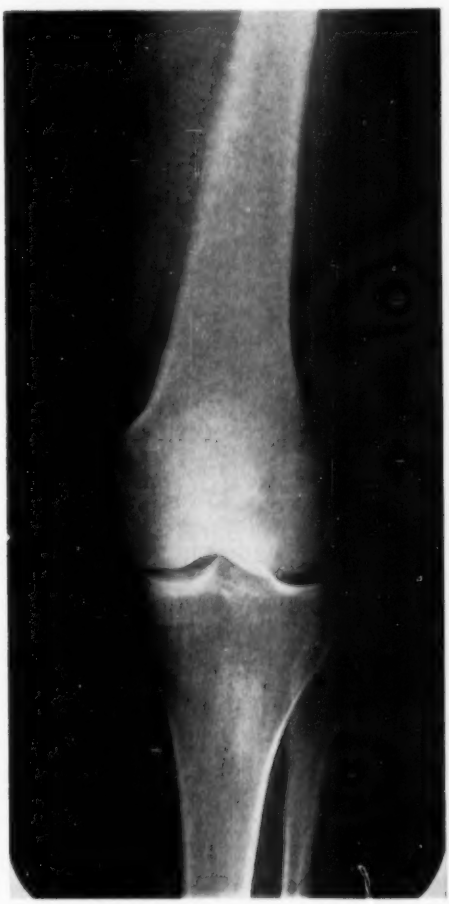

Fig. 4.—X-ray of left femur, knee, tibia, and fibula, demonstrating extensive subperiosteal new bone formation along the medial aspect of the distal shaft of the femur, typical finding of pulmonary hypertrophic osteoarthropathy.

In view of the above findings a thoracotomy was done. At operation a tumor 1.5 cm. in diameter was found in the fissure between the right middle and lower lobes, arising from the middle lobe bronchus. Frozen section revealed malignant growth, but no malignant mediastinal nodes were found. Pneumonectomy was done after which the patient made an uneventful recovery. From the second postoperative day on the pain in her ankles and knees was relieved and she noted that the swelling in her fingers was subsiding. The pain has not returned since the operation.

The pathologist reported that there was continuity of the tumor mass with the bronchial lumen of the inferior division of the right middle lobe. The cellular structure was characteristic of adenocarcinoma of the bronchus.

COMMENT

The case we have presented shows the same findings as those brought forth by Wierman and his associates in that arthralgia was an outstanding feature, which disappeared after the tumor was removed. Wierman states that not one patient in the suppurative and tuberculous groups complained of arthralgia and that this manifestation was practically always due to either a pleural mesothelioma or a pulmonary malignant lesion. Furthermore, Wierman believes that pleural stimulation or pleural involvement by the thoracic lesion may possibly be a factor in the pathogenesis of pulmonary osteoarthropathy. In our patient the tumor presented in the fissure between the middle and lower lobes, involving the pleural surfaces in the fissure. Most of the cases previously reported have been squamous-cell carcinoma rather than adenocarcinoma as was found in our patient. Apparently cell type is not a factor in the production of pulmonary osteoarthropathy.

Cough, hemoptysis, chest pain, wheezing, dyspnea, unresolved pneumonia, and weight loss are commonly described as the symptoms of lung carcinoma. Little emphasis has been placed on pulmonary osteoarthropathy. In this patient it was the presenting and only sign.

From a review of the literature it appears that it may be that the emphasis has been placed on the late signs and symptoms and that pulmonary osteoarthropathy, if searched for, might prove to be an early sign which in a considerable number of patients would lead to a diagnosis at a time when the disease is curable. To illustrate this point, we recently saw a patient, with cancer of the lung,

in a chest conference. The patient had been carefully examined and studied. His symptoms dated back three months. No mention had been made in the history or examination of osteoarthropathy. His fingers, however, were obviously clubbed. When we called the patient's attention to his fingers he said they had been that way for over a year. He also had arthralgia, which had been passed over lightly.

CONCLUSIONS

A case is presented and the literature reviewed to call attention to the fact that osteoarthropathy with painful joints and clubbing of the fingers may occur from 2 to 36 months before the classic symptoms and signs of carcinoma of the lung occur. These are signs that can be easily overlooked and that may be present in more patients than the literature would indicate. We feel that if all of us were alert to the implications of pulmonary osteoarthropathy a considerable number of very early lung carcinomas would be discovered in a curable stage.

Republic Building.

BIBLIOGRAPHY

Alvarez, C. H.: Clinical Diagnosis of Cancer of the Lung, J. A. M. A. **140**:364 (May) 1949.

Berg, R., Jr.: Arthralgia as a First Sympton of Pulmonary Lesions, Dis. Chest, **16**:483 (Aug.) 1949.

Brea, M. D.: Discussion of Dr. Pavlovsky, 1947 Year Book of Surgery, Chicago, The Year Book Publishers, Inc., 1948, pp. 306-307.

Brokos, H.: Concerning the Etiology of Hypertrophic Pulmonary Osteoarthropathy with a Report of 5 Additional Cases, Tr. A. Am. Physicians **28**:275-301, 1913.

Cecil, R. L., and Loeb, R. E.: A Textbook of Medicine, Ed. 8, Philadelphia, W. B. Saunders Company, 1951, pp. 1358-1359.

Craig, J. W.: Hypertrophic Pulmonary Osteoarthropathy as the First Symptom of Pulmonary Neoplasm, Brit. M. J. **1**:750 (April) 1937.

Deutschberger, O.; Maglione, A. A., and Gill, J. J.: An Unusual Case of Intrathoracic Fibroma Associated with Pulmonary Hypertrophic Osteoarthropathy, Am. J. Roentgenol. **69**:735 (May) 1953.

Flavel, G.: Some Unusual Manifestations of Bronchial Carcinoma, Brit. J. Tuberc. Supp. 47, pp. 135, 141 (Sept.) 1953.

Fried, B. M.: Pulmonary Osteoarthropathy: Dyspituitarism as Probable Cause, Arch. Int. Med. **72**:565-580 (Nov.) 1943.

Hansen, J. L.: Bronchial Carcinoma Presenting as Arthralgia, Acta med. scandinav. (Supp. 266) **142**:467-472, 1952.

Harper, F. R., and Watkins, D. H.: Differential Diagnosis of Thoracic Tumors, Am. Surgeon **20**:156-166 (Feb.) 1954.

Mauer, E. F.: On Etiology of Clubbing of Fingers, Am. Heart J. **34**:852-859, 1947.

Mendlowitz, M.: Clubbing and Hypertrophic Osteoarthropathy, Medicine **21**:269-306 (Sept.) 1942.

Pattison, J. D., Jr.; Beck, E., and Miller, W. B.: Hypertrophic Osteoarthropathy in Carcinoma of Lung, J. A. M. A. **146**:783-787 (June) 1951.

Rasmussen, H.: Peripheral Vascular Disease with Hypertrophic Osteoarthropathy as the First Manifestation of Bronchial Carcinoma, Acta med. scandinav. (Supp. 266) **142**:855-862, 1952.

Van Hazel, W.: Joint Manifestations Associated with Intrathoracic Tumors, J. Thoracic Surg. **9**:495-505 (June) 1940.

Wierman, W.; Clagett, O. T., and McDonald, J. R.: Articular Manifestations in Pulmonary Diseases: An Analysis of Their Occurrence in 1,024 Cases in Which Pulmonary Resection Was Performed, J. A. M. A. **155**:1459-1463 (Aug. 21) 1954.

Wyburn-Mason, R.: Bronchial Carcinoma Presenting as Polyneuritis, Lancet **1**:203-206 (Feb. 7) 1948.

Emergency Cervical Mediastinotomy for Massive Mediastinal Emphysema

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Minor degrees of subcutaneous emphysema and pneumothorax associated with fractured ribs or penetrating chest wounds are not uncommon. Usually this tissue air is spontaneously absorbed with little or no difficulty to the patient, and the physician is likely not to give it a second thought. Occasionally however, subcutaneous emphysema will become very widespread and create an alarming picture. In most such instances there is also a mediastinal emphysema which can produce enough tension within the mediastinum to threaten the patient's life. Since the mediastinal emphysema is a dangerous condition, this problem will be emphasized in the present discussion. Just how does air become trapped within the mediastinum?

PATHOGENESIS OF MEDIASTINAL EMPHYSEMA

In 1945, Hamman [1] gave an excellent review of this entire subject, especially from an internist's viewpoint. He pointed out various pathways followed by air in reaching or leaving the mediastinum and described the clinical manifestations and diagnosis. Loud coarse bubbling or crunching sounds heard over the precordium with each contraction of the heart have since become known as Hamman's sign.

Although there is a wide variety of causes of pneumomediastinum, through the years it has been demonstrated that most cases are secondary to rupture of pulmonary alveoli, with the production of interstitial emphysema of the lung. Macklin and Macklin [2] have experimentally shown how the air bubbles move along the intrapulmonary vascular sheaths towards the hilus of the lung. Once this process has started, with each breath more and more air is driven into the pulmonary interstitial tissue, thus further compressing the pulmonary vessels, and air steadily leaks into the mediastinum. If no egress is provided, death may ensue.

POSSIBLE SOURCES OF MEDIASTINAL AIR

1. *Trauma to Chest.*—Open injuries of the chest such as might occur from penetrating bullet or knife wounds are generally accompanied by subcutaneous crepitation in the immediate vicinity of the damage. In these cases air can be brought in from the outside or it can leak from a lacerated lung. Likewise, in a closed chest injury, if the lung and parietal pleura are torn by fractured ribs, pneumothorax and local subcutaneous crepitation are commonly seen simply by air passing from the lung tissue into the pleural space and subcutaneous tissues. Sheinfeld [3] has written a thoughtful paper analyzing 20 cases of subcutaneous emphysema following chest trauma. He emphasized that the mechanism of pulmonary interstitial emphysema is often responsible for pneumomediastinum.

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Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

One of his patients had a closed chest injury with fractured ribs culminating in an extensive distribution of subcutaneous air involving the entire body. An emergency cervical mediastinotomy was done, with satisfactory decompression and recovery. Gaudralt and Chalmers [4] reported a similar instance of a man in whom a severe subcutaneous emphysema appeared after he fell on his chest and fractured several ribs. This patient experienced prompt relief of dyspnea and cyanosis after a cervical mediastinotomy. Traumatic subcutaneous emphysema is also sometimes encountered after induction of pneumothorax and is the commonest complication of closed pneumolysis.

2. *Excessive Straining.*—Another common cause of mediastinal emphysema is excessive straining. Abnormal increase in intrapulmonary pressure may result in rupture of alveoli and pulmonary interstitial emphysema. Iglauer [5] and also Van der Laan and Maresh [6] have independently reported successful cervical mediastinotomies done for severe pneumomediastinum caused by coughing, secondary to upper respiratory infection. Allergists have long been familiar with the danger of mediastina emphysema in their asthmatic patients, and many such reports are in their literature. Karns and Daue [7] had such a patient in critical condition, with severe generalized subcutaneous emphysema; air bubbled freely out of a cervical mediastinotomy, with immediate improvement in the cyanosis.

Not infrequently during peroral endoscopy there is some struggling and straining associated with coughing. Abbott and de Oliveira [8] reported a case in which severe dyspnea, left tension pneumothorax and subcutaneous air throughout most of the neck rapidly developed. Suspecting a probable rupture of the esophagus, they did an emergency thoracotomy. No injury to the esophagus was demonstrated, although a 4 cm. rent was found in the mediastinal pleura. After this a cervical mediastinotomy was performed. They postulated that this patient represented clinical support of Hamman's contention that interstitial emphysema led to mediastinal air under pressure, which in turn ruptured out into the pleural space. Hammond [9] described a one-year-old patient from whom he removed a piece of apple from the main bronchus through the bronchoscope. Shortly afterward the child presented the shocking picture of much air under the skin of the entire body, dyspnea, and cyanosis. A cervical mediastinotomy provided release of trapped air, and the boy recovered.

Mediastinal and subcutaneous emphysema also have been reported during childbirth, during positive-pressure anesthesia, with voluntary holding of breath during underwater swimming, and as the result of an obstructed airway.

3. *Spontaneous Mediastinal Emphysema.*—Minor degrees of air within the mediastinum are being diagnosed with increased frequency by our medical colleagues. Fagin and Schwab [10] collected 39 cases of mediastinal emphysema, and in about half of them they could find no contributory factors. The condition appeared as a surprise in an otherwise apparently healthy person. In most of them no treatment is necessary. Mead and Stafford [11] successfully did a cervical mediastinotomy on a patient who spontaneously developed mediastinal and subcutaneous emphysema concomitant with tuberculosis of the left lung. There was no associated injury or straining. Sometimes a spontaneous pneumothorax from a ruptured pulmonary bleb will cause enough pressure on the lung to force air into the mediastinum.

4. *Perforation of Esophagus or Tracheobronchial Tree.*—It is obvious that perforation of either the esophagus or trachea is responsible for prompt appearance of pneumomediastinum, but this fact is usually overshadowed by the accompanying infection which invariably occurs. The operation of cervical mediastinotomy has long been a standard procedure in order to drain a mediastinitis secondary to such perforation. Seybold and co-workers [12] reported 50 cases of esophageal perforation at the Mayo Clinic since 1907. Most of these were due to

esophagoscopy, dilatation, or foreign body. Twenty-one cervical mediastinotomies were done, with only 5 deaths. Jessup [13] reported an ethylene explosion in a 16-year-old girl during childbirth. She began coughing large amounts of foamy blood. A few minutes later, her neck became distended with a large accumulation of air which spread rapidly. Death followed 50 minutes later, and an autopsy showed a jagged hole 1 cm. in diameter in the right main bronchus. It is sometimes extremely difficult to decide whether or not there has been a rupture of the bronchus, since mediastinal and subcutaneous emphysema are seen both with and without such rupture. Scannell [14] reported an interesting case of ruptured bronchus in a boy who developed a severe degree of subcutaneous air, hemoptysis, and pneumothorax after being run over by a car. He approached this problem in a somewhat more radical manner and proceeded with emergency thoracotomy, suturing a laceration of the right main bronchus and removing part of a torn upper lobe.

5. *From Neck Operations.*—Mediastinal emphysema and pneumothorax are complications that the surgeon operating on the neck must always keep in mind. Formerly it was believed this was due to accidental injury to the pleura, but now it is realized that air can gain entrance to the mediastinum through the opening of the middle layer of the deep cervical fascia. This condition is encouraged by an associated partial respiratory obstruction with exaggerated respiratory movements. Air is sucked in during inspiration and trapped there by the partial closure of the opening during expiration. When the intramediastinal pressure is sufficiently high, the mediastinal pleura can rupture, with resultant unilateral or bilateral pneumothorax. Bowden and Schweizer [15] presented an excellent review of the anatomy of the cervical fascia and analyzed 20 examples of this problem seen at Memorial Hospital, New York City. These complications are also not infrequently seen after tracheotomy. In fact, Forbes and co-workers [16] reported mediastinal emphysema in 24% of all tracheotomies and pneumothorax in 10%. As suggested earlier, this air within the mediastinum can be secondary to interstitial emphysema following excessive straining, or the air can enter directly through the tracheotomy incision.

6. *From Peritoneal or Retroperitoneal Areas.*—Recent advances in technique have made pararectal air insufflation more popular as a diagnostic procedure in suspected adrenal and other retroperitoneal pathology. After this injection air can flow upward through the aortic or esophageal openings into the mediastinum. Air also has been purposely introduced into the mediastinum as a diagnostic study in certain intrathoracic tumors. Jessup described a death which followed the inadvertent opening of the midportion of the diaphragm during a difficult splenectomy. Air was sucked in through this defect; the next day the neck veins were distended and the patient died. A postmortem examination showed the borders of the lungs widely separated in the midline, owing to a large amount of air under tension within the mediastinum.

REPORT OF CASES

Case 1.—Mr. M. S., a 63-year-old white man, was admitted to the Santa Barbara Cottage Hospital at 10 a. m. on Nov. 25, 1951, about an hour after an automobile accident. He was in moderate shock, and a small amount of crepitation was palpated over the left thoracic wall. X-rays made on admission revealed fractures of the left fifth through ninth ribs, inclusive, with slightly increased density of the left pleural space, but there was no evident pneumothorax. The following morning some hemoptysis was present, but no progression of the subcutaneous air was noted until 48 hours after the injury. On Nov. 27, the patient developed a most remarkable degree of subcutaneous emphysema, which extended down both arms to below the elbows, covering the entire neck, thorax, and abdomen, and even including both legs down to knee level. There was moderate dyspnea and cyanosis; chest x-ray revealed practically a total collapse of the left lung. Constant suction then was applied to the left pleural space by means of an intercostal catheter. The diagnosis of rupture of a major bronchus was considered but discarded because of the time interval which elapsed before the appearance of symptoms of progressive emphysema. Dur-

ing the next day x-rays showed complete reexpansion of the left lung, and the general condition was improved. Cyanosis was absent, and the progress of the subcutaneous emphysema apparently had been arrested.

On Nov. 29, there was a rapid increase in the amount of the subcutaneous air, and both eyes were swollen tightly shut with marked edema of the eyelids. The neck became horribly distended, and the facial features were unrecognizable to his family. Air had distended the scrotum to nearly football size and had dissected down the extremities to include all the fingers and toes. By pressing one's hand on any portion of the body one could squeeze away the subcutaneous air, leaving a depressed or pitted area about 1 in. below the general level of the skin. This deterioration in his condition occurred despite satisfactory functioning of the suction on the intrathoracic catheter. Chest x-ray at this time once again revealed a tension pneumothorax on the left with about 50% collapse of the lung and separation of the fragments of the fractured ribs. By early afternoon death appeared imminent, as he was very restless, dyspneic, and cyanotic, despite administration of oxygen.

It was obvious that the patient could stand little additional trauma. In desperation he was taken to the operating room and under procaine hydrochloride (Novocain) anesthesia a rapid cervical mediastinotomy was performed through a transverse incision in the suprasternal notch. The trachea was exposed and followed down into the mediastinum so that the great vessels were easily palpable. A considerable quantity of trapped air escaped from the mediastinum and kept steadily bubbling up during the operation. A large Penrose drain was placed deeply into the wound and the skin partially closed around the drain. Within three hours a dramatic improvement was indicated by the diminishing of the facial and eyelid emphysema, the improvement in color, and the absence of dyspnea. That evening the left lung was again fully expanded, and there was now a safety valve for release of air from both the pleural space and the mediastinum.

By the next morning, Nov. 30, the patient could easily open his eyes and was breathing quietly. From then on, progress was steady and impressive. The residual air in the subcutaneous tissues of the entire body gradually absorbed so that it had largely disappeared from the face and neck after one week and from the upper extremities after two weeks. On Dec. 16 he was dismissed from the hospital, 17 days after operation and 22 days after the accident.

Case 2.—Mr. F. M., a 96-year-old white man, was in custodial care in the geriatrics division of the Santa Barbara General Hospital. On Feb. 2, 1954, after an episode of coughing not considered to be severe, he suddenly developed an extensive crepitation of the neck which rapidly spread to the face, chest, and abdomen. He became markedly dyspneic and cyanotic within a very short time, and the subcutaneous emphysema was steadily increasing to an impressive degree. X-rays failed to reveal pneumothorax. Because of the patient's extreme discomfort and dyspnea it was felt that he was suffering primarily from pulmonary interstitial emphysema which had dissected towards the hilus, causing air to be under tension within the mediastinum.

That same afternoon, with the use of procaine hydrochloride (Novocain), a cervical mediastinotomy was performed, and during this dissection much air bubbled out of the mediastinum. Immediately after the operation the patient's condition began to improve dramatically, and by evening the subcutaneous emphysema had receded considerably; the cyanosis had disappeared and breathing was easier. Three days after the operation, despite an apparent gain in strength, he began to fibrillate, and from then on there was a progressive decline terminating in death 18 days after the onset of the final illness. Autopsy confirmed an extensive pulmonary emphysema. The actual cause of death was heart failure secondary to bronchopneumonia.

Case 3.—Mr. E. W., a 67-year-old Negro man, had suffered with pulmonary emphysema for many years and in January, 1954, first experienced a severe spontaneous right pneumothorax; this recurred in March, 1954. His final admission to the Santa Barbara General Hospital occurred on April 7, 1954, after a third episode of right pneumothorax. At this time he was dyspneic, and there was a considerable degree of subcutaneous emphysema in the right side of the face, shoulder, neck, and chest. Suction was again applied to the right pleural space, but despite this his condition became worse. Subcutaneous air progressively extended over the entire upper two-thirds of his body, including the upper portion of both arms, and the eyes were swollen shut. The neck presented the greatest amount of swelling, and he became very restless and dyspneic, with an irregular pulse. Because of his critical condition an emergency cervical mediastinotomy was performed on April 9, with the use of procaine hydrochloride (Novocain) anesthesia. Air steadily escaped from the mediastinum during the operation, and a Penrose drain was left in the wound. Within a few hours the subcutaneous air had greatly diminished, and by evening he was breathing much better and appeared to have passed the crisis.

However, x-ray studies three days later showed that a 50% collapse of the right lung still existed. Consequently a second intercostal catheter was also placed into the right pleural cavity. Careful thought was given to the possibility of resecting the portion of right lung containing the emphysematous blebs, in view of the repeated acute episodes of pneumo-

Fig. 1 (Case 1).—Chest x-ray made two days after the injury, showing left pneumothorax and extensive subcutaneous emphysema.

Fig. 2 (Case 1).—Chest x-ray made the day after cervical mediastinotomy. Note the complete reexpansion of the left lung and the decrease in the amount of subcutaneous emphysema. The safety-pin is on the Penrose drain extending into the mediastinum.

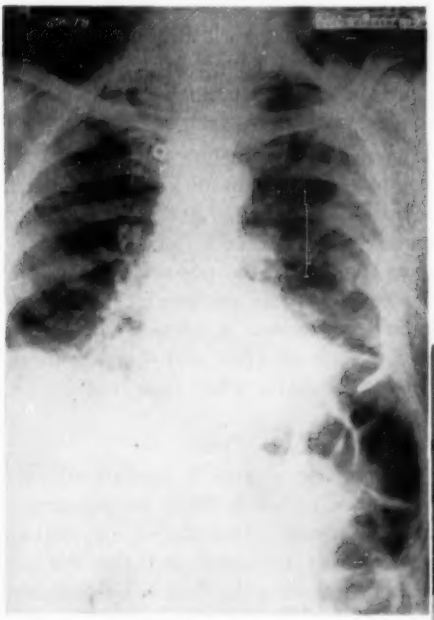

Fig. 3 (Case 1).—Close-up view of the patient just before the cervical mediastinotomy was performed. The depressed area below the left clavicle is where subcutaneous air was squeezed away just before the photograph was made.

thorax. Because the patient developed cardiac failure it was believed that he was not a good enough risk for such major surgery. He continued to decline and died on April 26, 1954.

COMMENT

These cases demonstrate three possible causes of pulmonary interstitial emphysema. Patient 1 sustained a severe blow to the chest wall, as evidenced by the fractured ribs. It is felt that this results in a compression of one part of the chest, which leads to a sudden increase in intra-alveolar pressure sufficient to cause rupture of the bases of the alveoli into the perivascular spaces within the lung. Moreover, lung tissue can sustain sufficient direct damage by fragments of fractured ribs to initiate the interstitial emphysema. It is extremely unusual to see a patient with subcutaneous emphysema of such a massive degree, spreading to involve the entire body from the top of the head to the toes.

Fig. 4 (Case 1).—The legs and arms are also distended with subcutaneous air. Note the scrotal enlargement.

Case 2 is an instance of rupture of alveoli due to the straining associated with coughing. Although the coughing did not appear to be excessive, it was evidently severe enough to cause the pneumomediastinum in a very elderly man with established emphysema.

Case 3 is a classic example of repeated spontaneous rupture of emphysematous blebs of the lung and resultant pneumothorax. There was no chest trauma or excessive straining. The logical explanation is that, with the sudden rupture of a bleb, some segments of collapsed lung may result in hyperinflation in other portions of this lung, which in turn can cause rupture of the bases of alveoli into the pulmonary vascular sheaths.

We have so far not encountered any patients who have gotten into serious difficulty owing to entrance of air into the mediastinum from neck incisions, ruptured esophagus, or trachea, or from retroperitoneal air insufflation

There are three possible routes that air may take in leaving the mediastinum: (1) through the superior thoracic inlet and up into the tissues of the neck, (2) down through the aortic, vena cava, or esophageal openings in the diaphragm and into the peritoneal cavity or retroperitoneal tissues, (3) by rupture through the mediastinal pleura into the pleural space.

Since there is little therapeutic possibility in either of the latter two routes, attention is directed to the tissues of the neck as the logical place for decompression. This must be done in order to relieve critical pressure on vital blood vessels within the mediastinum. Years ago multiple subcutaneous incisions were sometimes made in patients with massive subcutaneous emphysema, but these were usually not of much value, because they failed to decompress the mediastinum directly. The mere existence of air in the subcutaneous tissues is not dangerous. Air under pressure within the mediastinum is dangerous.

INDICATIONS FOR MEDIASTINOTOMY

The presence of much air at the suprasternal notch associated with a spreading subcutaneous emphysema is usually a significant observation, often serving as the first hint of an underlying pneumomediastinum. Anteroposterior chest x-rays frequently fail to reveal lesser degrees of mediastinal emphysema, and lateral views are usually more helpful in establishing the diagnosis. In cases in which mediastinotomy may be indicated, dyspnea, cyanosis, elevated pulse rate, and shock are often observed. If the patient's vital signs are not deteriorating and the progression of the tissue air is slowing, then no active intervention is necessary, aside from devoting effort to keeping the lung expanded by suction on the appropriate pleural space. Even if a bronchus has ruptured, it will often seal over if one can prevent the life-endangering effects of a tension pneumothorax or pneumomediastinum. Patients who have undergone cervical mediastinotomy need very little special attention once the operation has been completed and the dyspnea and cyanosis have been relieved. The Penrose drain should be removed about the third or fourth day. We were gratified by the prompt improvement in all of these patients as soon as the mediastinotomy had been performed. The operation is simple to complete in a few minutes under local anesthesia, and its timely use may prove a life-saving measure.

These cases convincingly demonstrate the value of cervical mediastinotomy for tension pneumomediastinum, just as emergency drainage of the pleural space can be life-saving in a tension pneumothorax. The relationship between pneumothorax and mediastinal emphysema is a close one. Either one can cause the other, and it is sometimes impossible to decide which came first.

SUMMARY

The possible sources of mediastinal emphysema are reviewed. Air in the pulmonary interstitial tissue is the underlying mechanism in most instances, and this can be caused by trauma to the chest or by excessive

straining or is occasionally seen to develop spontaneously. Other sources of mediastinal emphysema are direct perforation of the esophagus or trachea, open neck operations, or air ascending from retroperitoneal and intraperitoneal areas.

Three unusual cases are presented illustrating severe degrees of mediastinal and subcutaneous emphysema. All these patients obtained dramatic and at least temporary life-saving benefit from the use of emergency cervical mediastinotomy. This operation is simple to perform, and in such cases should be tried before resorting to formal thoracotomy.

There is a close relationship between pneumothorax and pneumomediastinum.

REFERENCES

1. Hamman, L.: Mediastinal Emphysema, J. A. M. A. **128**:1, 1945.

2. Macklin, M. T., and Macklin, C. C.: Malignant Interstitial Emphysema of the Lungs and Mediastinum as an Important Occult Complication in Many Respiratory Diseases and Other Conditions, Medicine **23**:281, 1944.

3. Sheinfeld, W.: Subcutaneous Emphysema Following Chest Trauma, Surgery **23**:278, 1948.

4. Gaudralt, G. L., and Chalmers, D. M.: Emergency Treatment of Traumatic Emphysema of the Mediastinum, New England J. Med. **224**:940, 1941.

5. Iglauer, S.: Spontaneous Mediastinal Emphysema, Ann. Otol. Rhin. & Laryng. **53**:823, 1944.

6. Van der Laan, W. P., and Maresh, G.: The Significance of Mediastinal Emphysema, New England J. Med. **235**:617, 1946.

7. Karns, J. R., and Daue, E. O.: Mediastinotomy in Spontaneous Mediastinal Emphysema, J. A. M. A. **136**:622, 1948.

8. Abbott, O., and de Oliveira, H. R.: Spontaneous Pneumothoraces Occurring in Patients Undergoing Peroral Endoscopy, J. Thoracic Surg. **14**:453, 1945.

9. Hammond, A. E.: Emergency Cervical Mediastinotomy in a Case of Massive Mediastinal and Subcutaneous Emphysema Secondary to Removal of a Foreign Body from the Bronchus, Ann. Otol. Rhin. & Laryng. **53**:829, 1944.

10. Fagin, I. D., and Schwab, E. H.: Spontaneous Mediastinal Emphysema, Ann. Int. Med. **24**: 1052, 1946.

11. Mead, R. H., and Stafford, F. B.: Spontaneous Interstitial Emphysema in Pulmonary Tuberculosis, Am. Rev. Tuberc. **21**:578, 1930.

12. Seybold, W. D.; Johnson, M. A., and Leary, W. V.: Perforation of the Esophagus, S. Clin. North America **30**:1155, 1950.

13. Jessup, P. M.: Mediastinal Emphysema, A. M. A. Arch. Surg. **20**:318, 1930.

14. Scannell, J. G.: Rupture of the Bronchus Following Closed Injury to the Chest, Ann. Surg. **133**:127, 1951.

15. Bowden, L., and Schweizer, O.: Pneumothorax and Mediastinal Emphysema Complicating Neck Surgery, Surg. Gynec., & Obst. **91**:81, 1950.

16. Forbes, G. B.; Salmon, G., and Herweg, J. C.: Further Observations no Post-Tracheotomy Mediastinal Emphysema and Pneumothorax, J. Pediat. **31**:172, 1947.

Sleeve Resections of the Trachea

Experimental Studies on Regenerative Capacity and Principles of Reconstruction and Repair

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One of the most attractive concepts in the field of modern medicine is that of replacing diseased tissues with healthy ones or substitutes that will restore the function of the afflicted organ to normalcy. Such examples as skin grafting, vascular homografts and autografts, and bone grafts are cases in point. In addition to using organic tissues, inorganic materials consisting of plastic "heart valves," tantalum, or stainless steel in the form of wires, struts, nails, plates, screws, and meshes have all been used with varying degrees of success.

However, one of the most persistently unsatisfactory organs to which this principle has been applied is the trachea, and this is so despite the fact that many ingenious schemes have been employed. Invasion of the trachea or bronchi with tumor, either intrinsic or extrinsic in origin, has sometimes been the factor determining operability. On a few occasions, the cervical trachea has been damaged in the course of severe injury, and its repair and the maintenance of an airway are the factors determining whether or not the patient survives the injury.

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From the Department of Surgery and the Bonfils Tumor Clinic, University of Colorado School of Medicine, Denver, Colorado. Supported from a grant by the American Cancer Society and Damon Runyon Fund.

This report outlines our effort to contribute to the resolution of this problem and presents some general principles of repair of complete or "sleeve" defects in the cervical trachea which we hope will serve as a guide to successful achievement of this objective in humans. The conclusions are based on work done on 75 different dogs over a two-and one-half-year period.

REGENERATIVE POWERS OF THE TRACHEA

Our interest in this problem was stimulated by the work on bridging arterial defects. After an arterial homograft is used to bridge a defect, a new intima will grow across this artificial stent (the homograft) from either end of the host artery until the entire lumen becomes lined with viable intimal cells.[26] This will occur within 24 to 36 hours. After this, the tensile strength and support of the new graft is supplied by other types of cells (fibroblasts, etc.) plus continued survival of the elastic tissue of the grafts. The end-result from the point of view of function is a serviceable conduit even though microscopically there still exist differences from the normal artery.

The ability of the trachea to heal when an end-to-end anastomosis * without tension is attempted or when small window defects are created † is well established. Contributions concerning complete circumferential or "sleeve resections" are not so plentiful. Yet the desirability of a practical scheme for repairing such defects does exist. If the body possessed the capability of forming a new "trachea" or suitably good functioning conduit over a stent (the temporary stent then being removed), the problem would be solved.

* References 15, 17, and 23.

† References 2, 3, 6, 7, and 18.

Early optimism crediting the bronchus or trachea with such purposeful and accommodating behavior can be attributed to the work of Daniels ‡ and co-workers. These authors created complete circumferential defects in dogs, bridged the defect with tubes, and then studied the animals at intervals of 2 weeks to 14 months. They concluded: "Small islands and rings of new cartilage were growing in the granulation tissue. It is believed that this cartilage develops from fibroblasts growing in the granulation tissue."

Our results indicate that, however encouraging this early work may have been, any successful attempt at repair depending upon the formation and function of such "cartilage" is open to serious question. The disappointments come through failure of this newly formed "cartilage" to perform the one function that it must not fail in if the repair is to be a success—namely, the maintenance of a rigid lumen that will not collapse and obstruct the airway.

REGENERATION FROM THE CUT ENDS OF THE HOST TRACHEA

If tracheal regeneration occurs, it must come from either of two sources (Fig. 1), namely, the raw ends of the host trachea or the adjacent soft tissue bed. The scheme in our first group of dogs consisted of bridging the defect with various types of stents which were placed over the outside of the tracheal stumps (Fig. 2). It was hoped that the tracheal epithelium might spread across on the inside of the stent from either end of the cut tracheal segments to form an airtight and functional lining. When a solid tube is used in this fashion, it is possible to determine the degree and rate of regeneration from the host trachea and to distinguish this from any regeneration that might take place from the surrounding soft tissue bed.

‡ References 4 and 14.

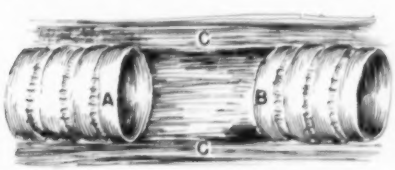

Fig. 1.—If tracheal regeneration takes place, it can originate only from (1) the raw tracheal ends, (2) the adjacent soft tissue bed *C*, or (3) a combination of the two sources.

Fig. 2.—Schema type 1: Prosthesis fitted over cut tracheal stumps (*A* and *B*). Only minimal regeneration from these raw ends occurs. Death usually results from stenosis at *A* and *B*.

Our results with this scheme were not successful. The tracheal stumps showed only a very limited ability to breach the gap in any such fashion. There was a regrowth in each case averaging 2 to 4 mm. after which the attempts at healing terminated in a rounded bud of tissue characterized by fusion of all layers of the tracheal wall. This in essence was simply a scar and the development of this scar marked the end of any further healing. Not only did the trachea fail to demonstrate any tendency to "line" the stent, but in actuality as the terminal bud of scar tissue developed, it produced a circular stricture of sufficient severity to cause death by asphyxiation in a sizable proportion of the animals.

REGENERATION FROM ADJACENT SOFT TISSUE BED

Since no material help could be anticipated from the cut tracheal ends, we turned our investigation towards the only other source of regeneration, i. e., the adjacent soft tissue bed. Our first efforts consisted of using stainless steel mesh only. These animals all died from two to four weeks postoperatively from respiratory obstruction. The dogs recovered from the operation without difficulty and at first had perfectly clear airways. As they were observed over the succeeding days, however, unmistakable signs of respiratory obstruction appeared. The autopsy then showed that the obstruction in each case was produced by granulation tissue growing from all sides through the permeable mesh until complete or nearly complete obstruction developed (Fig. 3).

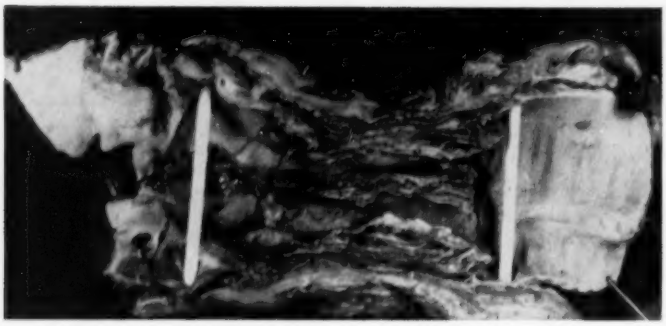

Fig. 3 (Dog 10).—Complete resection wire mesh stent—death eight days postoperatively from exudation producing obstruction.

It seemed apparent that if the previously reported islands of cartilage and abortive epithelium did in fact occur, that it needed more time to do so. Also, while this was taking place, some barrier must be provided around the mesh that would hold out the obstructive granulations which caused death in the early postoperative days so that time might be gained for this phenomenon to occur. A variety of schemes was tried (Fig. 4). Briefly these consisted of employing aortic homo-

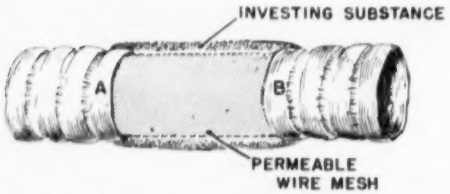

Fig. 4.—Schema type 2: Permeable prosthesis placed inside tracheal stumps (*A* and *B*) and covered with skin, fascia, gelatin, homografts, etc. Failure due to absorption of investing substance and invasion of lumen by granulations.

grafts, fascia lata, and sheets of gelatin and skin, all of which were wrapped around the wire mesh. We were not successful in a single one of these methods. The skin grafts never seemed to take, and the rest of the materials gradually disintegrated. As this took place and gaps in the continuity of the barrier substances developed, granulation tissue again gained access to the air passage and the familiar signs of respiratory obstruction appeared which subsequently proved fatal.

The incidence of infection in this group was higher than in the earlier experiments. The homografts and fascia simply sloughed and behaved much like foreign bodies. The gelatin sheets melted and disintegrated apparently within a few hours. The skin grafts behaved no better. This disturbed us, since Gebauer's methods had been so successful in humans. It is worthy of note, however, that all his successes have been in "window" defects and that no success by this method has to our knowledge been reported in sleeve resections. The excessive mobility of the dog's neck undoubtedly was a contributing factor in the failure of these schemes. Considering the size of the free grafts of fascia and skin that were employed and the mobility of the grafted field, plus the constant bathing of this field with secretions, it would seem hardly possible for any real "take" of these tissues to occur.

STENOSIS—THE PRIME ENEMY TO SUCCESSFUL REPAIR

The natural response of the body to wounds, wherever they may occur, is the development of granulation tissue as part of the healing process. This phenomenon is the physiological counterpart of the physical axiom "nature abhors a vacuum" and in most instances must be considered a beneficial occurrence. In the repair of tracheal defects, however, it is the most troublesome factor. An analysis of our failures up to this point indicated that obstructive granulations were

the commonest cause of our defeats and that the granulations produced obstruction by six different mechanisms (Fig. 5).

These may be listed as follows: 1. Healing from the cut tracheal ends will produce a circular scarring obstruction. 2. If a permeable stent is used, granulations will grow through the wall of the stent. 3. If the tube is too long, the ends of the tube will produce a pressure ulcer of the tracheal mucosa capable of producing a granulating obstruction. 4. If the disproportion between the tube and the cut tracheal ends is too great, granulations will creep in through the gap, with the same result. 5. If the sutures break and there is separation of the tube and tracheal stumps for this reason, the same thing will occur. 6. If the tension is too great, the terminal rings of the tracheal stumps will be cut through by the sutures so that a gap appears and a way is now open for similar encroachment on the airway lumen by granulation tissue. In any event it is clear that stenosis is the prime enemy of successful repair of tracheal defects and that any scheme of repair must be based on measures that will prevent this from occurring.

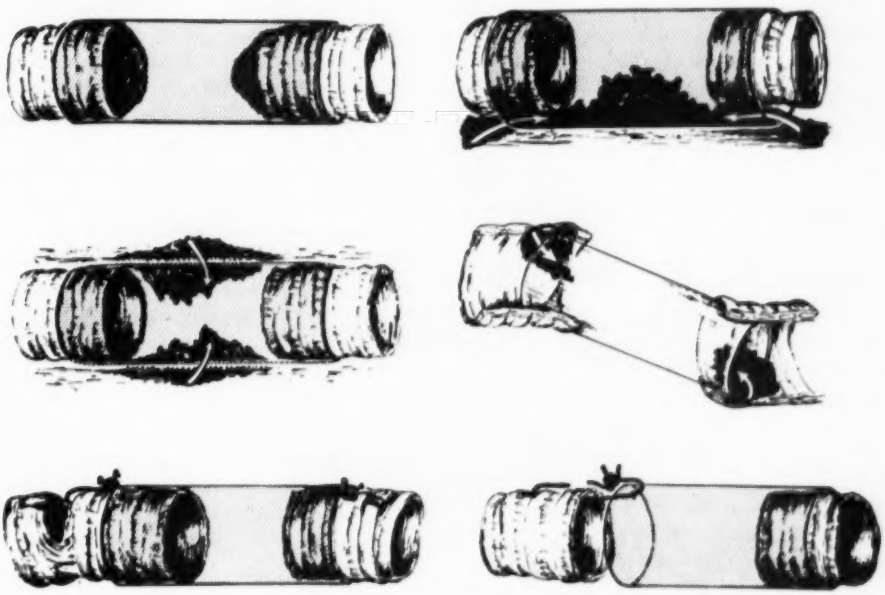

Fig. 5.—Six common causes of failure in tracheal repair. Upper row: left, granulations which form on the cut edges of trachea narrow the lumen; right, disproportion between tube and trachea permits ingress of granulations. Middle row: left, permeable mesh permits the granulations to grow through wall; right, tube is too long, producing granulation ulcer in tracheal mucosa. Bottom row: left, suture cuts through tracheal ring, causing breach in continuity; right, suture breaks, causing breach in continuity.

PERMANENT *vs.* TEMPORARY PROSTHESIS

The concept of leaving in a prosthesis permanently has three possible disadvantages: first, the possibility of the material itself acting as a foreign body, second, the possibility of physiologic disturbances of nerve supply so that dust, mucus, etc. will not be properly expelled and pulmonary sepsis will result; third, the possibility of dislodgment of the prosthesis, with resultant obstruction of the airway. Belsey [10] states, "Whatever method of reconstruction is adopted an uninterrupted ciliated mucosal lining is probably essential to success and any method based on the principle of an indwelling tube which cannot be incorporated in the regenerative tissue and so

permit complete regeneration of normal mucosa will probably lead to progressive pulmonary sepsis."

We continued, therefore, to attempt to develop a scheme which would result in a rigid, serviceable conduit capable of performing satisfactorily so that the stent would only have to be left in a brief time and might then be removed permanently. A polyethylene tube was again used and placed inside of the cut tracheal ends (since the earlier work had indicated that stenosis from scarring at the tracheal ends was sufficient by itself to produce failure) (Fig. 6). Number 28 stainless steel wire anchoring sutures were used. The wires were brought through the wall of the tube and attached to adjacent soft tissues (tendons or strap muscles) that permitted

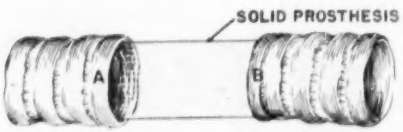

Fig. 6.—Schema type 3: Polyethylene tubing inside cut ends (*A* and *B*). Removal after three or four months. No regeneration from soft tissue bed. Later varied by wrapping with periosteum. No improvement. Conclusion: a permanent prosthesis is needed.

some "give" with motion and thus obviated cutting through adjacent tracheal rings. Around the outside of the polyethylene were placed strips of periosteum taken from the rib bed of the animal. It was hoped that the periosteum would survive and be the source of a rigid, cartilaginous, or bony support that would permit subsequent removal of the stent.

Again we failed. The dogs were x-rayed at four-week intervals for the presence of opacity in the operative area that might indicate bone formation. All 12 dogs operated upon by this scheme developed a purulent sinus. This resulted from failure of the periosteum to survive, with gradual dissolution and expulsion of the dead tissue. There was no microscopic evidence to confirm any hope that a supporting skeleton of tubular conformation sufficient to serve suitably as an airway had developed.

Despairing in our efforts to create a setting whereby the host tissues could be counted upon to create a good functional conduit without auxiliary support, we turned to testing the concept of inserting a solid tubular prosthesis as a permanent fixture. Clinical trial by other workers seemed to indicate that there were actually several materials available which could be counted upon to behave in an inert fashion. Longmire [16] used a jury rig Lucite tube when unexpectedly confronted with a severed cervical trachea following severe injury in a 14-year-old boy that had created a complete circumferential or sleeve defect. Jarvis [13] and Cotton [19] had used stainless steel tubes on a total of three human patients to bridge complete intrathoracic defects with enough success to warrant optimism. Clagett [12] used a polyethylene tube, but the patient died on the sixth postoperative day from disruption of the anchoring sutures and resultant dislodgment of the tube. In 1898, Bruns (cited by Cotton) used a permanent prosthesis to fill a sleeve defect resulting from removal of thyroid cancer. The nature of his material was unspecified. In 1951, Ravitch (cited by Cotton) used tantalum mesh plus skin in a human subject whose postoperative course was complicated by the tube slipping out of position twice but who was still alive at the end of a 16-month follow-up.

The experience in the use of foreign materials in other parts of the body as for recurrent inguinal hernias, large ventral hernias, etc., plus the rare scattered reports listed above made it clear that fear of intolerance of properly selected foreign materials seemed not to be justified. There were other pitfalls, however, and the most frequent fault consisted either in purposely removing the stent after varying periods of time or in inadvertently dislodging the stent through disruption of its moorings. For example, Longmire's patient seemed to be getting along reasonably well up to 10½ months. At this point, the author became acquainted with the experimental work of Daniels, which appeared to indicate that after a while sufficient regeneration would occur to make the continued retention of a stent unneces-

sary. He removed the Lucite tube but had to reinsert it because of collapse of the remaining air channel.

Jarvis also removed his stainless steel tube, basing his action on Daniel's experimental work, with a result similar to Longmire's, namely, that the enforced reintroduction of the prosthesis became necessary owing to collapse of the airway. In Ravitch's and Clagett's cases, the tubes became loosened inadvertently, and in addition to collapse of the air channel resulting from removal of the stent support, the newer hazard of bronchial obstruction by the tube itself appeared. Ravitch was able to salvage his patient by reinsertion of the tube, but Clagett's died too quickly for any such corrective procedure to be carried out.

Besides the fact that we were unable to find any experimental or clinical evidence to support the concept of a temporary prosthesis, there were other obvious advantages to the use of a permanent prosthesis. The reconstructive phase of an operation is reached only after several hours have been used to remove diseased tissue. Fatigue on the part of the operating team and the undesirability of further prolongation of the trauma to the patient becomes of importance. Under these circumstances the simpler and less elaborate the scheme of reconstruction the better for all concerned. We accordingly now returned to the simplest of all schemes. After sleeve resections of the trachea, a tube was introduced inside the cut ends of the tracheal stumps. The availability, cheapness, and adaptability of polyethylene made it a logical choice. This has proved to be our most successful group of dogs.

Any difficulty that was encountered in this group was traced to disruption of the mooring sutures with resultant dislodgment of the polyethylene tube. This led to investigation of various methods of fixation and ultimately two schemes proved to be far more successful than any of the others. The first of these schemes consisted in suturing the tube of adjacent tendinous and soft tissue structures with No. 28 stainless steel wire (Fig. 7). Usually, three such sutures at either end of the tracheal stump sufficed to provide adequate fixation. When these mattress sutures were thus tied over adjacent soft muscle tissues or tendons which have some "give" to them, our results were much more successful than when such sutures were fixed only to the tracheal rings. Of 10 dogs having this type of reconstruction, 9 were followed for periods up to one year and are doing well. One of these animals died as a

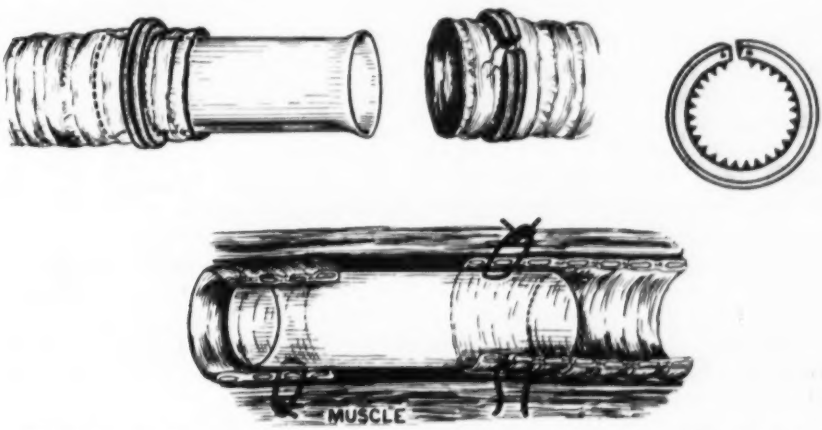

Fig. 7.—Upper row: a method of tube fixation utilizing principle of Hufnagel's aortic valve ring; tube is seen inside lumen of trachea; a plastic ring affords multiple-point fixation. Lower row: alternate method: use of polyethylene tube and wire sutures (longitudinal section).

result of obstruction produced by a granulating ulcer resulting from an overly long tube which had eroded through the tracheal wall.

Recently, Hufnagel's scheme of multiple-point fixation as employed on cardiac operations has been called to our attention. We have borrowed from his idea and used his nylon ring in conjunction with the simple flanged polyethylene tube. Of eight dogs having reconstruction by this method there have been no fatalities attributable to the scheme. These dogs have now been followed for five months.

Despite the theoretical objections, the expulsion of secretions from the respiratory tree across the polyethylene stent has not been a problem. The dogs have maintained a cough reflex and seem not to be troubled with excessive cough, and pulmonary sepsis has not been a factor. In humans, a tracheostomy (carried out if necessary right through the anterior wall of the polyethylene tube) could be counted upon to help keep the lungs and trachea clear in the early postoperative days.

SUMMARY AND CONCLUSIONS

The trachea has no unique capabilities of regeneration or repair any more than does skin, bone, or cartilage. Obstruction of the airway by granulation tissue coming from the raw tracheal stumps or the adjacent soft tissue bed is the cause of failure in most repairs. Host structures cannot be counted upon to form a rigid serviceable, supporting conduit after removal of a stent.

Under these circumstances, any scheme of repair must include the insertion of a nonpermeable tube afixed inside the raw tracheal ends with nonabsorbable sutures. These should preferably be anchored to some adjacent structures that possess the ability to give with stress. Experimental and clinical experience suggest that the insertion of this tube should be looked upon as a permanent thing and that there is no safe period after which the stent can be safely removed. Polyethylene is readily available and is as serviceable as any material available to do the job. A scheme for fixation of this prosthesis is suggested based on experimental trial in animals.

REFERENCES

1. Jackson, T. L.; Lefkin, P.; Tuttle, W., and Hamptom, F.: An Experimental Study in Bronchial Anastomosis, J. Thoracic Surg. **18**:630, 1949.

2. Gebauer, P. W.: Plastic Reconstruction of Tuberculous Bronchostenosis with Dermal Grafts, J. Thoracic Surg. **19**:604, 1950.

3. Gebauer, P. W.: Further Experiences with Dermal Grafts for Healed Tuberculous Stenosis of the Bronchi and Trachea, J. Thoracic Surg. **20**: 628, 1950.

4. Daniel, R. A., Jr.; Taliaferro, R. M., and Schaffarzick, W. R.: Experimental Studies on the Repair of Wounds and Defects of the Trachea and Bronchi, Dis. Chest **17**:426, 1950.

5. Carter, M. G., and Strieder, J. W.: Resection of the Trachea and Bronchi, An Experimental Study, J. Thoracic Surg. **20**:613, 1950.

6. Gebauer, P. W.: Tuberculous Bronchostenosis: Pathology and Treatment, Hawaii M. J. **10**: 423, 1951.

7. Gebauer, P. W.: Experiences with Surgical Reconstruction of the Trachea, Am. Rev. Tuberc. **62**:176, 1950.

8. Rob, C. G., and Bateman, G. H.: Reconstruction of the Trachea and Cervical Esophagus, Brit. J. Surg. **37**:202, 1949.

9. Burnett, W. E.: Discussion of Papers on Tracheobronchial Grafts, J. Thoracic Surg. **20**:650, 1950.

10. Belsey, R.: Resection and Reconstruction of the Intrathoracic Trachea, Brit. J. Surg. **62**:200, 1950.

11. Jackson, T. L.; O'Brien, E. J.; Tuttle, W., and Meyer, J.: The Experimental Use of Homogenous Tracheal Transplants in the Restoration of Continuity of the Tracheobronchial Tree, J. Thoracic Surg. **20**:598, 1950.

12. Clagett, O. T.; Grindlay, J. H., and Moersch, H. J.: Resection of the Trachea: An Experimental Study and Report of a Case, Arch. Surg. **57**:253, 1948.

13. Jarvis, F. J.: Discussion of Papers on Tracheobronchial Grafts, J. Thoracic Surg. **20**: 649, 1950.

14. Daniel, R. A., Jr.: The Regeneration of Defects of the Trachea and Bronchi: An Experimental Study, J. Thoracic Surg. **17**:335, 1948.

15. Grindlay, J. H., and Mann, F. C.: Surgical Uses of Polythene: An Experimental Study, Arch. Surg. **56**:794, 1948.

16. Longmire, W. P., Jr.: The Repair of Large Defects of the Trachea, Ann. Oto., Rhin. & Laryng. **57**:875, 1948.

17. Ferguson, D. J.; Wild, J. J., and Wangenstten, O. H.: Experimental Resection of the Trachea, Surgery **28**:597, 1950.

18. Cahan, W. G.: Carcinoma of Intrathoracic Trachea: Excision and Repair by Tantalum Gauze-Fascia Lata Graft: Report of a Case, J. Thoracic Surg. **23**:5, 1952.

19. Cotton, B. H., and Penido, J. R. F.: Resection of the Trachea for Carcinoma, J. Thoracic Surg. **24**:231, 1952.

20. Grimes, O. F., and Stephens, H. B.: The Surgical Treatment of Carcinoma of the Hypopharynx, Larynx, and Upper Esophagus, J. Thoracic Surg. **24**:246, 1952.

21. Gebauer, P. W.: Three Stage Tracheobronchial Reconstruction in Tuberculous Stenosis, J. A. M. A. **149**:538, 1952.

22. Berman, E. J.: The Experimental Replacement of Portions of the Esophagus by a Plastic Tube, Ann. Surg. **135**:337, 1952.

23. Craig, R.; Holmes, G., and Shabert, E.: Tracheal Resection and Replacement with Prosthesis, J. Thoracic Surg. **25**:384, 1953.

24. Gebauer, P. W.: Reconstructive Surgery of the Trachea and Bronchi: Late Results with Dermal Grafts, J. Thoracic Surg. **22**:568, 1951.

25. Davies, O. G.; Edmiston, J. M., and McCorkle, H. J.: Repair Experimental Tracheal Defects with Fresh and Preserved Homologous Tracheal Grafts, J. Thoracic Surg. **23**:367, 1952.

26. Swan, H.; Robertson, H. J., and Johnson, M. E.: Arterial Homografts: The Fate of Preserved Aortic Grafts in the Dog, Surg., Gynec. & Obst. **90**:568, 1950.

Cancer of the Esophagus

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During the past 23 years, 603 patients with carcinoma of the esophagus have been admitted to the Veterans Administration Hospital, Hines, Ill. An analysis of these patients has been undertaken to determine the incidence of this disease in relationship to total admissions and to malignancies of other organs and to note any change in its frequency. As this time interval covers periods of various forms of therapy, a comparison of results has been computed.

Prior to 1946, "Hines" was a tumor center for veteran patients from the entire country. This explains the higher percentage of admissions of patients with malignant diseases before this date. In 1946, Deans Committees were established to help supplement professional staffs of Veterans Hospitals. Tumor services were developed throughout the country to handle malignant disease locally. As a result, statistics at "Hines" depict the incidence of malignant disease in the veteran population of the local community served by this hospital.

INCIDENCE

The incidence of carcinoma of the esophagus during the past few years has been constant and has represented approximately 0.1% of the total hospital admissions (Chart 1). Carcinoma of the esophagus represents approximately 3% of admissions for primary malignant disease, as is shown in Chart 2. The relationship of the numerical admissions of carcinoma of the esophagus to other common malignant diseases is shown in Chart 3. In these three charts, it is evident that the incidence of this disease remains fairly constant, and there have been no significant variations during the period of this study. Thus the impression that carcinoma of the

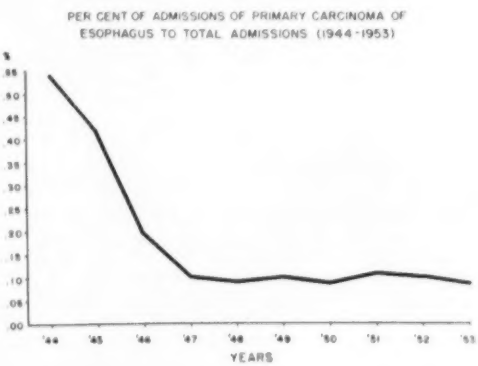


Chart 1.

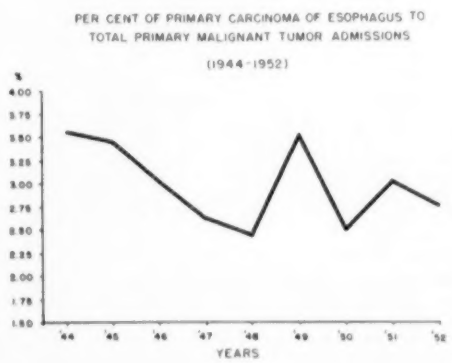


Chart 2.

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

Chief, Surgical Service, Veterans Administration Hospital, Hines, Ill., Clinical Professor of Surgery, University of Illinois College of Medicine, and Chief Surgeon, Henrotin Hospital (Dr. Puestow); Assistant Chief, Surgical Service, V. A. Hospital (Dr. Gillesby), and Resident in Surgery, V. A. Hospital (Dr. Guynn).

esophagus is increasing in frequency is not substantiated. It is of interest to note that carcinoma of the lung has increased remarkably, despite the fact that patients with this disease are being accepted in almost all other Veterans Administration Hospitals.

The esophagus is usually divided into its upper, middle, and lower thirds for anatomical consideration of its diseases.

Franklin [8] reports carcinoma of the esophagus as 25% in the upper third, 45% in the middle third, and 30% in the lower third. Humphreys and Moore [11] and Chauncey [4] report a similar incidence.

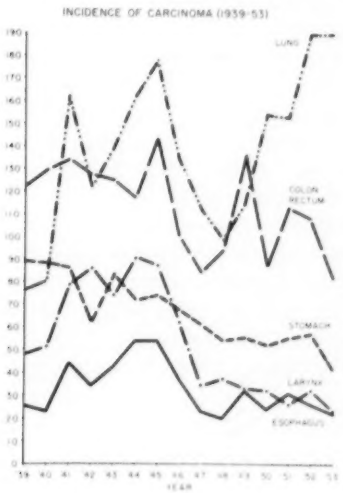


Chart 3.

In our series (Table 1), carcinoma was found in the lower third of the esophagus in nearly 40% of patients. When carcinoma involves both the lower esophagus and proximal stomach, the primary location may be undeterminable. In some of our patients malignant disease may have originated in the stomach and extended into the esophagus.

PATHOLOGY

Approximately 90% of carcinomas of the esophagus are squamous cell carcinomas, and approximately 10% are adenocarcinomas, with variations in the nomenclature used.

CARCINOMA ESOPHAGUS

LOCATION OF LESIONS	1939-44	1944-49	1949-54	TOTAL
UPPER 1/3	14	14	15	43
MIDDLE 1/3	78	82	53	213
LOWER 1/3	79	89	65	233
TOTAL CASES	171	185	133	489

Table 1

The question arises as to whether adenocarcinomas at the lower end of the esophagus are in reality primary in the esophagus or in the stomach. Adams and co-workers [1] found no adenocarcinomas of the upper third, and in our series we have found no adenocarcinomas in this area. The majority of the adenocarcinomas are found in the lower third near the esophagogastric junction. It is possible that many adenocarcinomas found at the lower end of the esophagus are truly primary in the stomach extending into the esophagus. We have had, however, five cases of adenocarcinoma definitely above the level of the cardia. One case is listed at the junction of the middle and lower third, and in four other cases the actual measurements from the incisor margin are given. These are 26 cm., 30 cm., 36 cm., and 37 cm., respectively. One case of definite adenocarcinoma was at the arch of the aorta. A possible explanation of this fact is that ectopic gastric mucous membrane may be present in the esophagus at any level; of course, it is commoner in the lower portion. Adenocarcinoma may also develop in glandular tissue

CARCINOMA ESOPHAGUS

CONTRIBUTING CAUSES OF DEATH IN 100 AUTOPSIED CASES

BRONCHOPNEUMONIA	48
CORONARY SCLEROSIS & MYOCARDIAL FIBROSIS	28
PULMONARY TUBERCULOSIS	9
LUNG ABSCESS	8
EMPYEMA	8

Table 2.

found at all levels. This question is not purely an academic one, as the prognosis in adenocarcinoma of the esophagus is definitely better than that of squamous cell carcinoma. In an analysis of the cases in one year, it was found that the average hospital survival was 46.8 days for squamous cell carcinoma, whereas in the adenocarcinoma group the survival was 181 days. This appeared to be uninfluenced by gastrostomy or x-ray therapy. The group analyzed was hospitalized before the era of esophageal resection.

PULMONARY COMPLICATIONS

In an analysis of 100 consecutive autopsied patients with carcinoma of the esophagus, pulmonary complications are seen to be very high, as shown in Table 2.

The secretion of saliva in the human ranges from 1200 to 1800 cc. daily. If this saliva cannot be carried from the pharynx to the stomach by a patent esophagus, overflow into the tracheobronchial tree is a frequent complication. The inability to swallow liquids and solids for purposes of nutrition is an important point in esophageal obstruction, but the inability to swallow saliva is even more important, because of the pulmonary complications. A gastrostomy or jejunostomy will, at least partially, eliminate the problem of nutrition, but does nothing to prevent pulmonary complications. Simple observation of a patient with complete esophageal obstruction emphasizes this point. He must carry a sputum cup to catch the saliva that is dribbling from his mouth, and his existence at night is miserable. He is able to sleep one and one-half to two hours and then awakens coughing because of saliva in his tracheobronchial tree. This episode is repeated several times throughout the night, and a good deal of his misery is due to interrupted sleeping hours. We feel that restoration of some means of handling saliva is an important consideration in the management of these cases.

RADIATION THERAPY

X-ray therapy has been used extensively in our series. We have not used rotational therapy, as recommended by Buschke,[8] but have used multiple port exposure methods and believe that the lesions have been adequately exposed to high-dosage x-ray. Survival times are shown in Table 3. A comparison of the survival times of patients with no treatment and those with x-ray treatment would tend to extol the virtues of x-ray. However, it must be remembered that many patients were unable to have x-ray therapy, either owing to intense morbidity or imminent mortality. Many of these cases were admitted with lung abscesses, empyema, and pneumonitis which contraindicated the use of x-ray therapy. Also, x-ray therapy is not

CARCINOMA ESOPHAGUS

SURVIVAL AFTER ADMISSION (INCLUDING SURGICAL MORTALITY)

	1939-44	1944-49	1949-53	TOTAL
CLINICALLY INOPERABLE OR NONRESECTABLE & X-RAY Rx	184 d. 102 c.	155 d. 97 c.	160 d. 44 c.	168 d. 243 c.
CLINICALLY INOPERABLE & NO Rx	46 d. 67 c.	54 d. 65 c.	55 d. 32 c.	51 d. 164 c.
EXPLORATION- NON-RESECTABLE, NO Rx	NONE	56 d. 7 c.	60 d. 10 c.	58 d. 17 c.

TABLE 3.—Average number of survival days (*d*); number of cases (*c*).

CARCINOMA ESOPHAGUS
(OPERATIVE MORTALITY)

	1939-44	1944-49	1949-54	TOTAL
THORACOTOMY	4-50%	35-34.3%	77-24.6%	116-28.4%
RESECTION AND ESOPHAGOGASTROSTOMY	2-50%	16-43.7%	47-31.9%	65-35.4%
NONRESECTABLE	2-50%	19-26.3%	30-13.3%	51-20%

Table 4.

CARCINOMA ESOPHAGUS
SURVIVAL TIME (EXCLUDING DEATHS IN FIRST 14 DAYS

	1939-44	1944-49	1949-54	TOTAL
RESECTION & ESOPHAGOGASTROSTOMY	NONE	9 (375 d.)	21 (319 d.)	30 (336 d.)
RESECTION & ESOPHAGOGASTROSTOMY & X-RAY Rx	1 (536 d.)	3 (302 d.)	11 (364 d.)	15 (343 d.)
NONRESECTABLE-WITH OR WITHOUT X-RAY Rx	1 (116 d.)	14 (116 d.)	26 (143 d.)	41 (176 d.)

Table 5.

CARCINOMA ESOPHAGUS
LONGEST SURVIVALS WITHOUT RESECTION

PATIENT AGE	LOCATION & TYPE	SURGERY	X-RAY Rx	CAUSE OF DEATH	SURVIVAL
B.N.- 45	30 cm. Sq. CELL	GASTROS.	7500r	NO POST	2 yrs. 9 mos.
P.K.- 48	20 cm. Sq. CELL	GASTROS.	9900r	NO POST	1 yr. 11 mos.
O.C.- 73	LOWER 1/3 ADENO. CA.	BIPASS OP.	NO	NO POST	1 yr. 8 mos.
H.N.- 45	40 cm. Sq. CELL	GASTROS.	6000r	GEN. MET. & PNEUM.	1 yr. 6 mos.
L.S.- 49	28 cm. Sq. CELL	GASTROS.	13,600r	GEN. MET.	1 yr. 5 mos.

Table 6.

an innocuous procedure. Two patients have been seen at Hines Hospital for whom a resection of the esophagus was performed with esophagogastrostomy. The thought of cure was entertained in both of these cases, and, to improve the patient's chances, x-ray therapy was advised and given. In both of these cases, within one year, acute tuberculosis developed, and the patients died of tuberculosis, activated, we believe, by the intensive x-ray therapy. This was during the era of streptomycin and *p*-aminosalicylic acid, but these drugs did not protect these patients against tuberculosis. After death in both of these cases recurrent carcinoma could not be found.

After x-ray therapy, we have also seen perforation of an esophageal carcinoma into the pleural cavity with fatal empyema resulting. We have also seen this complication without any x-ray therapy.[5] There is virtue in x-ray therapy, but there are also disadvantages, and one must carefully choose one's method of therapy.

SURGICAL THERAPY

We prefer surgical intervention, as it is possible that curative procedures can be performed in some cases. The operative mortality of exploration with resection or other procedure is shown in Table 4. The survival times are shown for those patients who survived operation and x-ray treatment (Table 5) and for those who had no resection, with or without x-ray treatment. Of those who survived, it is apparent that the survival time is well worth the effort in these cases. Survivals without resection are shown in Table 6. X-ray was used in all but one, in which case the lesion was an adenocarcinoma for which the prognosis is better than for that of squamous cell carcinoma, even without treatment. Table 7 shows the results in patient who underwent resection and esophagogastrostomy, alive or surviving two years or more. The longest survival was three years and seven months. This patient had an adenocarcinoma which could possibly have arisen in the cardia of the stomach. He died of an acute coronary occlusion, and no carcinoma was found at postmortem examination.

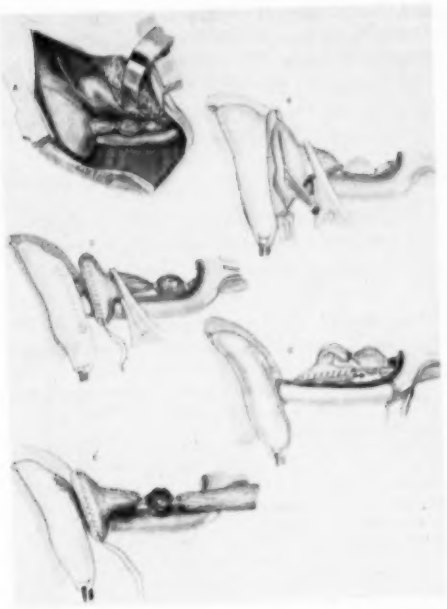
We believe that the contribution of Cole and co-workers to surgery for carcinoma of the colon, namely, ligation of the organ proximal and distal to the lesion, may be applicable to surgery of esophageal carcinoma.

CARCINOMA ESOPHAGUS

PATIENTS WITH RESECTION & ESOPHAGO-GASTROSTOMY ALIVE OR SURVIVING 2 YEARS

PATIENT AGE	LOCATION & TYPE	X-RAY Rx	CAUSE OF DEATH	SURVIVAL
E.T.- 64	37 cm. Sq. CELL	NO	STILL LIVING	2 yrs. 8 mos.
W.M.- 47	28 cm. Sq. CELL	7800 r	STILL LIVING	1 yr. 5 mos.
J. N.- 58	41 cm. ADENO. CA.	NO	CORONARY NO TUMOR	3 yrs. 7 mos.
S.L.- 59	33 cm. Sq. CELL	NO	GEN. MET. & PNEUM.	2 yrs. 7 mos.
E.F.- 63	17 cm. Sq. CELL	7600 r	NO POST	2 yrs. 2 mos.
C.C.- 57	22 cm. Sq. CELL	NO	LOC. REC. & GEN. MET.	2 yrs. 15 days

Table 7.



Left thoracotomy, seventh rib. *A*, ligation, esophagus, above and below tumor to prevent migration of exfoliative cells. *B*, division of stomach, including lymph nodes on the esophageal side. *C*, closure of stomach and lower end of divided esophagus, leaving suture ends uncut. *D*, insertion of acutely angled instrument under the aorta to grasp the long suture ends and deliver the esophagus from under the aorta. *E*, esophagus brought out from under the aorta and ready for esophagogastric anastomosis.

We are now ligating the esophagus above and below the tumor, as shown in the Figure. We do not know the incidence of recurrence due to exfoliation of cells and inclusion of the cells in anastomotic sutures, but we believe that this may be a possible factor.

As has been pointed out by Holmes,[10] lymph node involvement at the esophagogastric junction or on the lesser curvature of the stomach may be present regardless of the location of the carcinoma. If our present knowledge of the lymph flow along the esophagus is correct, this would suggest that the upper lymphatic channels have been blocked early in the disease and that the esophagogastric nodes are involved as a result of retrograde involvement. This would suggest that more extensive surgery is necessary in order to extend the benefits of the resection. A minimal resection at the lower end of the esophagus for small lesions usually is inadequate, and if there is any doubt as to the extent of the tumor, a supra-aortic anastomosis should be performed. Our method of freeing the esophagus from behind the arch of the aorta is shown in the Figure. We prefer a left thoracic approach and have not had the difficulty freeing the esophagus from the aortic arch that is reported by others.

We share the feeling of discouragement that pervades much of the recent literature but agree with Sweet[19] that an aggressive attitude results in better patient comfort. Our desiderata are to (1) lengthen the patient's life and (2) make his life more comfortable by restoring esophagogastric continuity.

SUMMARY

An analysis of 603 cases of carcinoma of the esophagus seen at the Veterans Administration Hospital, Hines, Ill., is presented.

Adenocarcinoma of the esophagus is a true entity and presents a better prognosis as to length of life than does the squamous-cell type.

Pulmonary complications are present in a high percentage of cases of esophageal obstruction owing to aspiration of saliva into the tracheobronchial tree.

X-ray therapy has limited value and presents definite hazards.

Ligation of the esophagus in the early stages of a resection above and below the tumor is advised to prevent exfoliation and inclusion of carcinoma cells in the line of suture.

Lymphatic extension of the disease is probably more extensive than has been realized, and it is believed that surgical excision will have to be extended if better results are to be expected.

We prefer the left-sided approach and present our method of handling the esophagus at the aortic arch.

REFERENCES

1. Adams, H. D.; Hare, H. F.; Davis, W. L.; Trump, J. G., and Granke, R. C.: The Treatment of Carcinoma of the Esophagus and Cardia by Resection and Postoperative Supervoltage Roentgen Rays, Ann. Surg. **138**:631-642 (Oct.) 1953.

2. Berman, E. F.: Carcinoma of the Esophagus: A New Concept in Therapy, Surgery **35**:822-835 (May) 1954.

3. Buschke, F.: Surgical and Radiological Results in the Treatment of Esophageal Carcinoma, Am. J. Roentgenol. **71**:9-24 (Jan.) 1954.

4. Chauncey, L. R.: Results of Surgical Treatment of Carcinoma of the Esophagus and Gastric Cardia: Follow-Up Study, A. M. A. Arch. Surg. **68**:872-885 (June) 1954.

5. Cliffton, E. E., and Blansfield, H. N.: The Treatment of Carcinoma of the Esophagus by Radiation Therapy and Surgery, Surgery **33**:748-753 (May) 1953.

6. Conerly, D. B., Jr.; Carlson, R. I., and Scott, H. W., Jr.: The Combined Anterior Surgical Approach to Carcinoma of the Upper Thoracic Esophagus, Surg., Gynec. & Obst. **98**:84-90 (Jan.) 1954.

7. De Bakey, M. E., and Cooley, D. E.: Palliative Resection for Carcinoma of the Esophagus, A. M. A. Arch. Surg. **66**:781-797 (June) 1953.

8. Franklin, R. H.: Surgery of the Oesophagus, Baltimore, Williams & Wilkins Company, 1952, p. 142.

9. Garlock, J. H., and Klein, S. H.: The Surgical Treatment of Carcinoma of the Esophagus and Cardia, Ann. Surg. **139**:19-34 (Jan.) 1954.

10. Holmes, G. W.: Carcinoma of the Esophagus, S. Clin. North America **34**:53-61 (Feb.) 1954.

11. Humphreys, G. H., II, and Moore, R. L.: Carcinoma Involving the Esophagus, S. Clin. North America **33**:389-400 (April) 1953.

12. Kastl, W. H.: Carcinoma of the Esophagus as a Complication of Achalasia, Surgery **34**:123-126 (July) 1953.

13. Mustard, R. A.: Reconstruction of the Oesophagus, S. Clin. North America **34**:979-995 (Aug.) 1954.

14. McGrew, E. A.; Laws, J. F., and Cole, W. H.: Free Malignant Cells in Relation to Recurrence of Carcinoma of the Colon, J. A. M. A. **154**:1251-1254 (April 10) 1954.

15. Noyes, M. B., and Iverson, R. K.: Cervical and Upper Thoracic Esophagogastrostomy in the Treatment of High Esophageal Carcinoma, Am. J. Surg. **86**:665-677 (Dec.) 1953.

16. Puestow, C. B., and Cross, J. H.: Carcinoma of the Esophagus, S. Clin. North America **31**:153-171 (Feb.) 1951.

17. Puestow, C. B., and Cross, J. H.: Transthoracic Approach for High Gastric Lesions, S. Clin. North America **31**:259-269 (Feb.) 1951.

18. Puestow, C. B.: Cancer of the Esophagus, Postgrad. Med. **16**:97-103 (Aug.) 1954.

19. Sweet, R. H.: Late Results of Surgical Treatment of Carcinoma of the Esophagus, J. A. M. A. **155**:422-425 (May 29) 1954.

20. Torek, F.: The First Successful Case of Resection of the Thoracic Portion of the Oesophagus for Carcinoma, Surg., Gynec. & Obst. **16**:614-617, 1913.

DISCUSSION

On Papers by Drs. Harper and Patterson; Rydell and Jennings; Morfit; Neerken; Prevedel; Liddle, and Kircher, and Puestow and Gillesby and Guynn

Dr. William H. Wierman, Denver: Mr. President, I would like to discuss Dr. Fred Harper's paper [Slide].

Lesion	Resections	Arthrop. Present	Incidence, %
Mesothelioma	14	8	57
Bronchiectasis	189	18	9.5
Lung abscess	34	6	17.6
Pulmonary cyst	30	3	10.0
Bronchogenic carcinoma	481	25	5.2
Tuberculosis	157	1	0.6
Miscellaneous	119	0	0.0
Total	1,024	61	6.0

This slide presents the frequency of occurrence of pulmonary osteoarthropathy as seen in 1024 pulmonary resections. Of the 61 patients exhibiting pulmonary osteoarthropathy, 55 had clubbing of the digits. Fifteen patients who had either a pleural mesothelioma or bronchogenic carcinoma complained of arthralgia, the clinical picture of which often masqueraded as rheumatoid arthritis. As with Dr. Harper's case, the arthralgia practically always preceded the development of pulmonary symptoms.

This information would appear to make mandatory the procurement of a chest roentgenogram for all patients complaining of arthralgia, or, for that matter, for any patient who has a diagnosis of rheumatoid arthritis.

As the increasing frequency of case reports has indicated, arthralgia and/or clubbing may be the earliest and only sign of bronchogenic carcinoma. Further, if the differential diagnosis of tuberculosis versus carcinoma arises in a patient exhibiting pulmonary osteoarthropathy, one could heavily rely on the diagnosis of carcinoma.

Dr. W. M. Tuttle, Detroit: I would like to discuss briefly the paper on subcutaneous emphysema.

It seems that the record should be kept straight on this subject. I do not believe that in the case which was demonstrated this morning the problem of subcutaneous emphysema in this patient was on the basis which Mackler described. That type of emphysema was perivascular in type, which is not manifested by a marked amount of air in the tissues and which is not benefited by any type of superior mediastinotomy.

The patient with perivascular emphysema who goes on to death generally dies from compression of the pulmonary capillaries rather than compression of the large vessels from air within the mediastinum.

When, in the patient demonstrated, the intercostal tube was placed in the chest (you will recall that the patient had a pneumothorax), the patient became more comfortable. Then the patient later developed a huge amount of subcutaneous emphysema. The x-ray taken after this development demonstrated the fact that the pneumothorax had recurred.

This patient did not need a superior mediastinotomy at all; all he needed was to have the tube readjusted within his space in order that the air under tension might escape.

You will recall from the x-rays that, in addition, to the superior mediastinotomy, the tube had been tampered with and pulled out a bit. I think the latter maneuver is what cured him. I do not believe the superior mediastinotomy had anything to do with it.

I have seen a great many cases of subcutaneous emphysema, and I have not thought it necessary to do a superior mediastinotomy except in the rare instance.

Another important thing which might have been done in this case is this: The tube should have been placed in the anterior upper chest. As far as I know, air rises to the top, and this tube was at the base and on the side. That is an incorrect place to put a thoracotomy tube when you wish to reduce a spontaneous pneumothorax.

Dr. John R. McDaniel, St. Joseph, Mo.: I should like to discuss the paper on mediastinal emphysema by presenting one of our cases which demonstrates some of the points mentioned and which also presents an unusual source of emphysema, that is, a closed perforation of the cervical trachea.

This case was in a 5-year-old boy who fell, striking the edge of a coffee table with his anterior neck. When we saw him in the emergency ward 30 minutes later, he had a massive emphysema extending from his head down to his feet. There was contusion of the anterior neck. We could not examine his chest because of the crepitation and subcutaneous emphysema present.

[Slide] This shows the marked emphysema involving all the soft tissues. There is a tension pneumothorax on the right and also on the left. The layer of air on the left is thinner than on the right.

[Slide] This slide shows the air in the soft tissues of the neck.

[Slide] This shows the air in the soft tissues of the legs and in the scrotum.

[Slide] This shows the situation after bilateral water-sealed intercostal drainage had been established. The lungs are expanding. However, you can still see air in the mediastinum tissues and also air in the neck and the subcutaneous and muscular spaces still is well demonstrated.

At this time the situation was not greatly improved. The patient was still cyanotic and dyspneic and very restless. Air was bubbling freely from the intercostal tubes.

[Slide] We did a tracheotomy at this point. During the dissection in the neck, air was seen to bubble with each exhalation from an area on the posterior surface of the trachea just below the junction of the trachea and the larynx. After the establishment of the tracheotomy, with the tube in place, this escape of air ceased. Blunt dissection was carried downward posterior to the sternum to facilitate escape of air from the mediastinum. The patient's condition improved immediately. [Slide] This last slide shows the lungs pretty well expanded, the mediastinum relatively free of air. This tracheotomy tube was removed in 10 days, and the patient's convalescence has been uneventful.

Dr. Fred R. Harper, Denver: Dr. Rydell and Dr. Jennings asked me if I would make a few remarks about their paper. It is my feeling that they have made a very excellent contribution and that there are cases of mediastinal emphysema which do need the type of drainage that they have described. Not all patients with mediastinal emphysema have accompanying pneumothorax.

I also want to emphasize the method they have described. It is a simple method which can be used easily. As George Gobel might say, "Those simple methods are something you don't hardly ever see no more."

The literature is full of articles of complicated techniques, generally applicable only to patients who have a survival rate of six months to a year. More thought should be given to saving the lives of young healthy persons suffering from accidental injuries; sometimes simple methods are sufficient to prevent their dying from some physiological maladjustment, such as blocked airway or tension pneumothorax.

The astonishing thing to me is that so often doctors do not appreciate that a tension pneumothorax or a blocked airway can bring about shock and death even though the blood volume has been entirely replaced. A simple thing like putting a needle in the chest and finding out if there is tension pneumothorax and then instituting the type of intercostal drainage that Dr. Rydell and Dr. Tuttle spoke of will often save a patient's life.

Another thing that will save a patient's life after chest injury is keeping the airway clear of secretions and blood. Sometimes this can be done by aspiration; or it can be done by bronchoscopy, but if this fails tracheotomy is indicated. I think a tracheotomy is a relatively simple procedure, which can be done

in the patient's room, and it is often a life-saving measure.

I also believe Dr. Rydell's and Dr. Jennings' simple method of mediastinotomy can be a life-saving measure.

DR. JOHN GRINDLAY, Rochester, Minn.: I would like to comment on the paper by Dr. Morfit and his colleagues concerning tracheal resection.

I believe one would be surprised at the amount of trachea that can be resected and still, if the neck is flexed, an end-to-end anastomosis be performed. I mention this only to suggest that, in nonmalignant disease especially, if the sutures are all placed before they are drawn up and tied then—I realize there are problems in aeration which the anesthetist has, but still they are not difficult if the sutures are placed with the neck flexed—whether it is resection of thoracic or cervical trachea, quite a lot can be resected and still be brought together with an end-to-end anastomosis.

I agree with Dr. Morfit that the permanent internal stent, such as he described, and which is similar to the one of Polythene that we use, works well; but there will usually be granulation tissue between the outer wall of that stent and the newly formed capsule of fibrous tissue that surrounds it. There will be more or less tracheal epithelium if the tube fits very well, not too snugly and not too loosely. We have had dogs which we killed at the end of six years, and up to their death they had no trouble so far as pulmonary disease distal to the tube was concerned.

The only trouble with tracheal resection is that usually it is performed for malignant disease and for slow-growing tumors of the lower trachea. When one is trying to do any type of resection and anastomosis in such patients, probably a tube which serves only as an airway is the best thing to insert. In Dr. Clagett's cases this has merely provided a couple of years of more comfortable existence for the patient.

I might add that (in the dog) we have found that nearly the whole thoracic trachea and bifurcation, both main bronchi, and the right lung, can be removed. When the neck is flexed, the stump of the bronchus on the left side can be joined to the end of the trachea. This procedure has worked very well in a series of dogs which we have now been observing for seven years.

DR. CHARLES PUESTOW, Chicago: Like so many things that are relatively new in surgery, early reports seem quite encouraging, and we think we have a great future with them. As time goes on, we become more and more discouraged. I think that applies to resection for carcinoma of the esophagus, and yet it has certain merits, and I believe in time will offer better results.

From the figures you saw, the average length of life of patients who did not have surgical removal of esophageal tumors was less than two months. Of those who had a resection, irrespective of the presence of metastases, the average length of life was one year. That is not long, but it does give them some added life. Mainly it gives them added comfort.

The problem of secretions going into the bronchial tree is a serious one, which is not relieved by gastrostomy or enterostomy; in fact, these procedures, I think, should be mentioned mainly to be condemned because they do not lengthen the patient's life; they do not relieve his esophageal obstruction, and they make him a socially ostracized person for what remaining time he has.

It is important to re-establish continuity of the alimentary tract from the mouth to the stomach. If this is accomplished and the patient is relieved of difficulty in swallowing and the discomfort of starvation, we are offering him a great deal of comfort. The patients who have a resection and who go on to a subsequent death from metastases live a more comfortable existence than those who do not have their lesions removed.

Recently my brother, who is a professor of medicine at the University of Wisconsin, presented a paper on conservative measures of relieving esophageal obstruction. I discussed the problem with him and told him that surgery did have something to offer also. I asked him about his reports, and he told me of one woman who had a positive diagnosis of a squamous-cell carcinoma of the esophagus made over eight years after the initial diagnosis had been made.

Thus, when we cannot resect the lesion, if we can devise a means of dilating the esophagus (and I think this can be done more frequently than we do), we can offer greater comfort and a longer survival to these patients.

However, our cure rate is not going to increase until the medical profession diagnoses carcinoma of the esophagus early and has the patient treated early. It is only then that we can expect to obtain a cure. Patients with esophageal carcinoma present symptoms early, but those we have seen have had symptoms for from six months to a year or longer and have lost from 25 to 75 lb. in weight before they were submitted for surgical therapy. That is too late.

DR. WILLIAM A. ALTEMEIER, Cincinnati: I should like to discuss the paper by Dr. Rydell regarding emergency cervical mediastinotomy.

I was very much intrigued with his interpretation of the sequence of events in the cases which he presented and with the method of treatment which he outlined.

At the Cincinnati General Hospital, injuries of the lung, both direct and indirect, which are associated with tension pneumothorax and mediastinal emphysema are not uncommon lesions. However,

extensive subcutaneous emphysema extending to the eyelids, as depicted in his case, and to the scrotum and to the lower legs has been an infrequent lesion except in those cases in which a tension pneumothorax was overlooked or treated inadequately.

It was for this reason that we believe in and practice the concept that the important and potentially lethal lesion is the tension pneumothorax. We teach further that a subcutaneous emphysema rarely, if ever, is a potentially fatal lesion. The emphasis, therefore, is placed on the early recognition and treatment of the tension pneumothorax with the installation of a mushroom catheter of sufficient size in the second interspace anteriorly in the midclavicular line.

If there is any question of the impairment of respiratory function produced by segmental fractures of the chest or by secretions within the tracheal tree, a tracheostomy is done, according to the recommendations of Carter and Giuseffi. This reduces the amount of tidal air, permits removal of the retained tracheal secretions, and permits better oxygenation of the lung.

DR. JOHN R. RYDELL, Santa Barbara, Calif.: I was hopeful that this paper would be productive of much stimulating discussion, and I have not been disappointed.

In reply to Dr. Tuttle, I can say only that the intercostal catheter appeared to be working. This patient had a special nurse on duty all night with him, and she reported that air was bubbling from time to time through the tube and that everything seemed to be satisfactory. When we irrigated the tube, it did not seem to be plugged.

I also should like to reemphasize what Dr. Harper has said about this being a simple operation. It is done under procaine hydrochloride (Novocain) anesthesia and can be done in the room if necessary. We took most of our patients to the operating room for the sake of convenience. It takes only a few moments to do and really is not much more than putting an intercostal catheter in the chest.

We do know that patients die from mediastinal emphysema. Many autopsies have been reported, indicating a tremendous distention of the mediastinum with air under pressure, causing a wide separation of the lungs. I do not have time to allude to individual cases specifically, but we do know that the mediastinal emphysema is a lethal condition potentially.

Certainly it is impressive, at the time of the cervical mediastinotomy, to see that air bubbling directly out through the incision into the mediastinum, and it also is striking to see the dramatic relief that these patients obtain.

DR. H. MASON MORFIT, Denver: I should like to thank Dr. Grindlay for his discussion of our paper. I am afraid we would have to conclude on the basis of our work that, we would not perform any of the procedures we have talked about today, including an end-to-end anastomosis, with so much confidence that we would go home and not worry about whether the patient might do well.

So far as we are concerned, we take a strong stand against the concept of ever relying on the host, the patient himself, to do much toward building a new trachea, regardless of the time that goes by. If we were forced to face this situation in the chest, on the basis of our work we would recommend the Hufnagel tube method, because we get a better air seal with this scheme than we do with the wire suture method that also was described.

Bilateral Simultaneous Breast Cancer

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and
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Operable carcinoma occurring simultaneously in both breasts at the time of the first examination is an uncommon clinical entity. Reference to it, however, was made by Nisbet,[1] in 1800, and since that time its presence has been noted frequently in most large series. Davis,[2] in 1919, alluded to it while reporting to this Association his operative experience with 166 breast cancers. Considerable interest was manifested shortly thereafter in the entire problem of bilateral breast carcinoma by Kilgore,[3] Greenough,* and McWilliams.[4] The very inclusive tabulations of Lewis and Rienhoff[5] and of Harrington[6] have established a firm statistical baseline for further studies. These six reports include a total of more than 12,000 patients of whom approximately 1% presented operable bilateral breast cancer at the time of the first visit.

In view of the apparent increase in incidence of breast cancer, a continuing interest is noted in the study of clinical variations of the natural biologic history of this disease. Extremes of host-tumor resistance phenomena are frequently noted. Growth patterns have been tabulated and correlated with numerous factors. From this a much better understanding of breast cancer has been made available to us by numerous investigators. The matter of multicentric origin of breast cancer is but another facet of this work. In addition, we have good evidence for believing that approximately 5% of all persons who develop a primary carcinoma live long enough eventually to produce a new second primary growth, irrespective of any consideration of paired organs.† For these reasons a further group of more recent reports on bilateral breast cancer have been reviewed by us in order to evaluate as accurately as possible current clinical experience as it is being reported in the light of these very interesting concepts. It is our purpose to present a brief consideration of bilateral simultaneous breast cancer plus a case report, with the hope that this may stimulate some pertinent discussion at this meeting. It is possible that we may demonstrate that the prognosis for these patients may not be as poor as one might otherwise casually estimate.

The occurrence of bilateral breast carcinoma is not difficult to imagine, since both breasts have the same structural pattern and the same genetic background and are under the same hormonal influences. Despite these observations, we are impressed with the considerable (96%) unilaterality of the disease. Since we know that there is such a high incidence of breast cancer among the female population, we cannot avoid some speculation as to why cancer is not commoner in both such paired organs. At the present time not one but a group of factors seems to be the accepted possible background for a carcinogenic effect upon the breast. The element of time as yet remains unclear. In experimental carcinogenesis it is often found that about 15% of an animal's life span is used for the development of a malignant growth after the introduction of a known carcinogen.

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Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

* Greenough, R. B., in discussion on Kilgore.[3]

† References 7 and 8.

In the breast this time factor is quite mysterious because, while cancers may appear in the two breasts almost simultaneously (within a few months), both malignant growths eventually may be proved to be quite separate. On the other hand, no contralateral primary growth is the usual finding, but, after an interval of from 3 to 15 years, in a few patients there will appear a new growth in the opposite breast that beyond all doubt is a separate primary carcinoma. While this tumor may have been present in minute form and, owing to the latent growth factor, may have been very slow to develop, it must be classified as nonsimultaneous with regard to its gross evidence of existence. Very often it is probable that many of these examples of late nonsimultaneous growths have probably existed in minute form for some time prior to their recent period of active maturation. Such a conclusion is suggested by the work of Hubbard,[9] who found small primary growths in the opposite breast when the latter was resected "prophylactically" in the absence of a palpable tumor.

TABLE 1.—*Incidence of Bilateral Breast Carcinoma*

Author, Year	Reported Cases	Total Bilateral		Patients Operated on	Simultaneous		Nonsimultaneous	
		No.	%		No.	%	No.	%
Davis 1920	166	8	4.9	166	1	0.6	7	4.2
Kilgore 1921	1100	37	3.3	659	13	2.0	13	2.0
Greenough 1921	639	35	5.4	609	5	0.8	8	1.3
McWilliams 1925	3132	154	4.9	1730	11	0.6	87	5.0
Lewis & Rienhoff 1932	950	45	4.7	950	14	1.5	31	3.2
Harrington 1946	6149	274	4.4	6149	62	1.0	212	3.4
Finney 1947	298	6	2.0	298	0	0	6	2.0
Desalve 1949	1373	99	7.2	1373	9	0.6	46	3.3
Clifton & Young 1951	708	15	2.1	545	5	0.9	..	...
				322*	..	...	10	3.0
Keyes & others 1951	633	53	8.3	633	2	0.3	..	...
				428*	..	...	25	5.8
Brachett-Brian 1951	2250	169	7.5	2250	109	4.8	60	2.3
Reese 1953	504	20	3.9	504	0	0	15	2.9
Hubbard 1953	275	29	1.0	267	3	1.1	9	3.4
Guiss 1954	1521	115	7.0	925	2	0.2	19	2.1
Total	19,698	1,059	...	17,048	236	...	..	...
				16,021*	..	...	548	...
Average incidence			5.3			1.4		3.3

* Patients successfully traced.

The educational status of the patients obviously will alter this figure in proportion to the degree of cancer-awareness propaganda in the community.‡ The lesions reported always will be larger than the sum of the operable simultaneous and nonsimultaneous cancers. When the series is reported from a hospital, the incidence corresponds more to the average therapeutic experience. On the other hand, when the data include a more comprehensive breast cancer population, such as a combined ambulatory clinic and in-hospital group of patients, the number of inoperable simultaneous bilateral breast cancers can be expected to be higher.

INCIDENCE

Table 1 contains a representative tabulation of the earlier reports as well as the more significant recent contributions pertaining to bilateral breast cancer. Owing to variations in methods of reporting and classification of patients a few inconsistencies will be noted, but the large number of patients (19,698) is such that reasonable averages can be obtained. To understand these figures better one must realize that, while the great majority of these patients represent operable cases, some authors also have included the inoperable bilateral simultaneous cancers as well as the obvious bilateral metastatic lesions. For this reason the total of bilateral

‡ References 12 and 13.

over-all average incidence for bilateral primary operable breast cancer thus is found to be a very firm 1%.

This figure should be compared with that of bilateral nonsimultaneous breast cancer. Perhaps the difference betwen simultaneous bilateral and nonsimultaneous bilateral primary breast cancer may be only an academic consideration, since the latent growth factor may be such as merely to confuse the evident appearance time. The significant point is the proof of the individuality of each tumor. For practical purposes we have considered the nonsimultaneous lesions to be those occurring in a patient upon whom a previous radical mastectomy had been performed for proved carcinoma and in whom some time later (at least two years) an evident independent new primary growth develops in the opposite breast without any evidence of metastatic involvement elsewhere. In the course of follow-up examinations after the second radical mastectomy the accuracy of this diagnosis is confirmed if the clinical course is similar to that often experienced by the average patient with a single operable primary, i. e., the absence of early appearance of extensive metastases. If metastases have occurred, it is obvious that the lesion in the second breast is merely early evidence of generalized metastases from the first lesion. The incidence of nonsimultaneous lesions will obviously rise with the increase in 10-year survival rates as well as with the thoroughness in follow-up.[14] Owing to variations in the latter, the average incidence of necessity must be calculated only with reference to those patients who have been successfully traced through the years. In Table 1 it will be found that the average appears to be 3.3%. This figure, of course, since it represents a retrospective evaluation, is smaller than the clinician will experience, because undoubtedly a few patients will be operated upon who at a later date will prove only to have shown examples of cross metastases (Table 2). In order to minimize this diagnostic error we feel that the time interval should be carefully observed. In the well-studied group of 34 nonsimultaneous lesions reported by Reese[15] and by Guiss,[16] an interval of three or more years was found in 30 patients. Hubbard[9] reported that 23 of his 26 patients had a five-or-more year interval between radical mastectomies. In these patients the clinical course has been satisfactory, while similar patients operated upon after less than two years have, as a rule, not done well.

TABLE 2.—*Distribution of Primary Breast Carcinoma Treated by Radical Mastectomy on Wolfer-Carroll-Shields Service Since January, 1943*

	No.	Per Cent
Patients operated on	173	100.0
Unilateral disease	165	95.4
Bilateral disease	8	4.6
Simultaneous	1	0.6
Nonsimultaneous	7	4.0
Metastatic	1	0.6

When bilateral breast cancer occurs, it immediately becomes necessary to establish whether each breast lesion is an independent primary tumor or one lesion is a metastatic manifestation of the other. This differentiation is important not only in regard to therapeutic implications but also to the individual's prognosis. In an effort to substantiate the individuality of each tumor the factors to be considered differ somewhat when the bilaterality is simultaneous as compared with nonsimultaneous. Billroth's criteria for the differentiation of multiple simultaneous primaries are not applicable in such cases, since the histologic picture may be completely similar and neither may as yet have metastasized. The criteria published by Warren and Gates[17] cannot be strictly applied because the possibility of one tumor being a metastasis of the other cannot be completely excluded, except through the factor of time. The factor of cross metastasis in breast cancer must always be considered, and the anatomic pathways of this avenue of spread have been well described. In an attempt to resolve this dilemma Guiss[16] has set down the following criteria for simultaneous breast cancer:

(1) The patient must present clinically independent lesions in each breast when first seen and be free

from evidence of metastatic lesions. (2) The history must be that of concomitant development of independent tumors. (3) The patient's clinical course following bilateral mastectomy must be free from evidence of early local recurrence which would suggest that the bilaterality of the process was merely metastatic in nature.

In the majority of instances these latter criteria when met will be quite sufficient to classify a patient who presents the problem of bilateral simultaneous breast carcinoma. When the clinician first sees a patient with bilateral disease, however, only the first two of the three criteria can be evaluated. If they are met, the treatment of choice for bilateral breast cancer is bilateral radical mastectomy, either as a staged procedure or at one sitting.

PROGNOSIS

The prognosis for bilateral simultaneous breast cancer is relatively poor. It has been shown to be worse than that for unilateral disease as well as that for bilateral nonsimultaneous disease. The most complete individual report on the matter is that of Harrington,[16] in which it is again pointed out that the presence or absence of axillary metastases is an important factor influencing the ultimate outcome in this group (Table 3). Among his patients with axillary metastases there was a 10-year survival rate of 5.4% as compared with 44.4% among those without axillary involvement. He reported no 15- or 20-year survivors among the former subgroup, but a 25 and 20% survival rate was found, respectively, among those free of axillary involvement.

It is of some interest to compare these figures with those reported for patients with nonsimultaneous bilateral breast cancer. The

TABLE 3.—*Survival After Radical Mastectomy* *

Primary Diagnosis	Survival, % of Cases			
	5 Yr.	10 Yr.	15 Yr.	20 Yr.
Without axillary metastases				
Bilateral simultaneous	57.7	44.4	25.0	20.0
Bilateral nonsimultaneous	78.5	59.1	42.2	26.5
Unilateral only	78.6	63.6	52.9	43.0
With axillary metastases				
Bilateral simultaneous	27.7	5.4	0	0
Bilateral nonsimultaneous	42.3	23.7	16.2	16.0
Unilateral only	32.8	19.4	14.0	9.2

* Percentage survival from follow-up of 7,822 patients after radical mastectomy for breast carcinoma (adapted from Harrington, S. W., *J. A. M. A.* **148**: 1007, 1952).

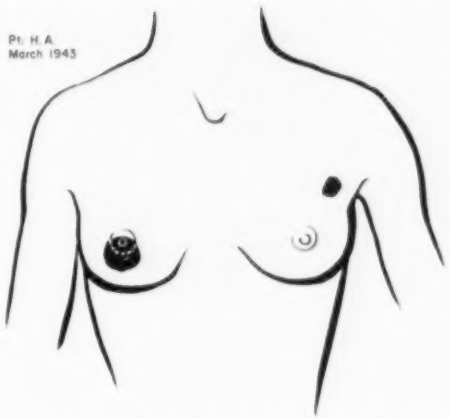


Fig. 1.—Locations of two primary bilateral simultaneous breast carcinomas in a 55-year-old woman.

Fig. 2.—Photograph of patient 11 years after bilateral radical mastectomy had been done. No sign of recurrence.

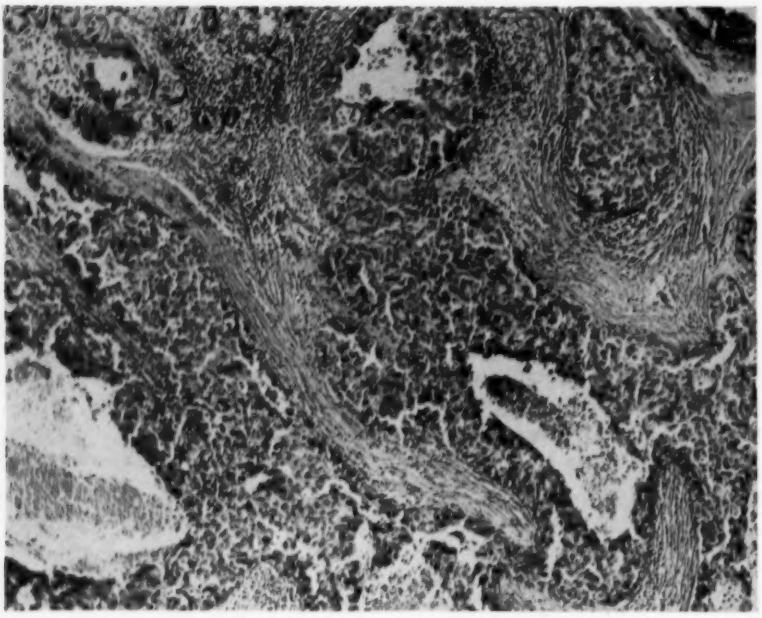
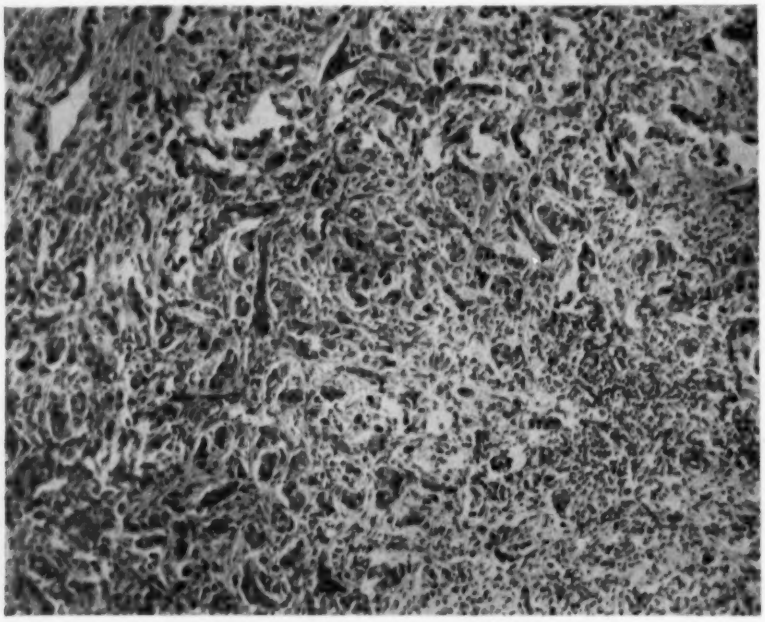


Fig. 3.—Photomicrograph of papillary adenocarcinoma from right breast. Hematoxylin and eosin. Reduced to 55% of mag. × 100.

Fig. 4.—Photomicrograph of scirrhous duct carcinoma metastatic to lone axillary lymph node from left breast lesion. Hematoxylin and eosin. Reduced to 55% of mag. × 100.



10-year survival figure for those with positive nodes was 23.7%, and it was 59.1% for those who had no axillary involvement. The comparable figures from the same source for unilateral disease are 19.4% and 63.6%. Other authors have reported the observation that survival after the second radical mastectomy in these patients is higher than is to be expected.§

REPORT OF A CASE

The patient, a 55-year-old white woman, entered Passavant Memorial Hospital on March 3, 1943, with the chief complaint of lumps in both breasts. She stated that she first felt a small mass in the upper outer portion of the left breast in May, 1942, while washing the armpit area. About two months later she became aware of a sense of heaviness in the right breast and on self-examination found a lump under the nipple. The patient was not particularly concerned and did not seek medical advice until approximately eight months later, when she entered the Northwestern University Medical School outpatient department because of further growth of the mass in the right breast (Fig. 1).

Physical examination revealed a 5.5-× 3.5 cm. mass in the central portion of the right breast. There was a slight retraction of the nipple, but no fixation to the skin was noted. In the left breast there was a 2-× 1 cm. hard mass in the extreme upper outer quadrant. By careful manipulation this lesion was found to be slightly adherent to the skin. No enlarged lymph nodes were palpated in either axilla or in the supraclavicular areas. The remainder of the examination revealed no significant findings. Routine urinalysis and hemogram were within normal range. Chest and skeletal roentgenograms were reported as normal.

On March 6, 1943, a right radical mastectomy was performed.‖ The patient tolerated the procedure well, and the postoperative course was uneventful. The pathologist reported the presence of a papillary adenocarcinoma of ductal origin (Fig. 3). Axillary lymph node metastasis was not demonstrated in 12 nodes examined. On March 20, 1943, a bilateral oophorectomy was performed through a low midline incision. This procedure and postoperative course were uncomplicated. On April 1, 1943, a left radical mastectomy was performed. The pathologist reported the tumor to be a scirrhous duct carcinoma with metastasis to one of eight axillary nodes (Fig. 4). The patient was discharged with the wounds well healed on April 17, 1943.

During the following four months 2400 mg. of testosterone proprionate were administered by the intramuscular route. No radiotherapy was given. Since surgery the patient has been followed at regular intervals for the past 11½ years. Her arm motion has been excellent, and there has been no lymphedema. She has had one episode of viral pneumonia necessitating hospitalization in 1951, but her subsequent clinical course has been uncomplicated. Recent chest x-rays and skeletal survey were reported as normal. When last seen, on Nov. 18, 1954, she was clinically free of evidence of recurrent disease (Fig. 2).

COMMENT

The clinical data in this case report indicate that the findings fulfil the criteria required for the diagnosis of bilateral simultaneous breast cancer. Both lesions were quite separate and independent, differing in their growth rates as well as in microscopic appearance. The slower growing carcinoma in the extreme upper outer quadrant of the left breast was accompanied by metastasis to a single small lymph node, which practically adjoined the primary lesion in the axillary process. The more rapidly enlarging tumor of the right breast, centrally located, did not produce any axillary node involvement, despite its relatively large size. The difference in microscopic appearance can be noted by examination of the accompanying photomicrographs. The very satisfactory clinical course further demonstrates that this bilaterality was not a manifestation of early cross metastasis.

Our patient demonstrates to some extent a degree of host-tumor resistance that appears to be better than one would anticipate with the phenomenon of simultaneous bilaterality. Approximately 10 months intervened between the discovery of the left breast lesion and definitive surgical care. During this period the right breast carcinoma developed slowly and eventually reached such size as to impress the patient with the need for treatment. The long period of growth without the development of gross nodal metastases argued well for extended survival. In unilateral disease with a history and find-

§ References 12 and 14.

‖ This patient was operated upon under the direction of Dr. John A. Wolfer, Emeritus Professor of Surgery and then Director of the Patterson Tumor Clinic at Northwestern University Medical School.

ings similar to those in this patient prognostic estimations have been far more accurate than when the reported duration is short, regardless of tumor size.¶ In this regard it has been shown that with a history of long duration a more accurate estimation of extended survival can be made as compared with those situations in which the patient presents a small tumor of short duration. In the latter instance the survival may be either long or short but the prognostic estimate is more dependent upon other criteria of biologic activity, i. e., cellular differentiation, lymph node metastases, and location of the tumor.

Just what importance the bilateral oophorectomy and course of androgen therapy played in this particular case is most difficult to evaluate. This additional therapy was used at a time when such a procedure was considered more of a clinical experiment than it is today. The patient was not premenopausal but gave an indication of continued estrogen activity. At the time, one of our colleagues, Abel,[21] was currently demonstrating the beneficial palliative effects of androgen therapy in preterminal uterine cancer ("frozen pelvis" patients). It is evident from this and similar work that the autonomy of some cancers arising from endocrine-related organs can be altered for a limited time by biochemical means. The mechanism of this antagonism has become a matter of considerable interest and significance in the whole field of cancer research. Definite clinical benefit from bilateral oophorectomy has been demonstrated by Horsley[22] in the premenopausal or menopausal woman who has undergone radical mastectomy. It is of further interest to note from Smith and Smith [23] that "prophylactic ovariectomy had prolonged life not only in women under 40 and over 59 years old but more so in those 40-59 years of age." Excellent microscopic confirmation of this ovarian influence upon survival in breast cancer has been shown by Sommers and Teloh.# Their correlation between hyperplastic ovarian cortical stroma and lower survival time was such as to warrant serious consideration for oophorectomy both before and after the menopause. Indications of ovarian activity were noted in many of the older patients. Although we believe that this form of supplementary therapy has a real place in our efforts to eradicate some forms of breast cancer, we are inclined to minimize its value in this particular patient.

¶ References 19 and 20.

References 24 and 25.

CONCLUSIONS

Primary bilateral simultaneous mammary carcinoma is uncommon, and its identification is dependent not only on the clinical findings but also on the patient's course subsequent to treatment. If the local lesions are resectable and metastatic disease can be ruled out, the treatment of choice is bilateral radical mastectomy after frozen section proof of the character and individuality of each lesion. This may be performed either simultaneously or consecutively, as preferred by the individual surgeon. The prognosis is not as favorable as with unilateral carcinoma or nonsimultaneously occurring bilateral disease, but it is not at all a hopeless situation.

REFERENCES

1. Nisbet, W.: A Case of the Cure of Cancer of Both Breasts, the One Ulcerated, the Other Scirrhous, Med. & Phys. J. **4**:296, 1800.

2. Davis, B. B.: Operative Results in 200 Breast Tumors, Ann. Surg. **71**:270, 1920.

3. Kilgore, A. R.: The Incidence of Cancer in the Second Breast, J. A. M. A. **77**:454, 1921.

4. McWilliams, C. A.: Bilateral Mammary Cancer Operations: Ultimate Results in 98 Cases, Ann. Surg. **82**:63, 1925.

5. Lewis, D., and Rienhoff, W. F., Jr.: A Study of the Results of Operation for the Cure of Cancer of the Breast, Ann. Surg. **95**:336, 1932.

6. Harrington, S. W.: Survival Rates of Radical Mastectomy for Unilateral and Bilateral Carcinoma of the Breast, Surgery **19**:154, 1946.

7. Warren, S., and Ehrenreich, T.: Multiple Primary Malignant Tumors and Susceptibility to Cancer, Cancer Res. **4**:554, 1944.

8. Slaughter, D. P.: The Multiplicity of Origin of Malignant Tumors: Collective Review, Internat. Abstr. Surg. **79**:89, 1944.

9. Hubbard, T. B.: Nonsimultaneous Bilateral Carcinoma of the Breast, Surgery **34**:706, 1953.

10. Finney, G. C.; Merkel, W. C., and Miller, D. B.: Carcinoma of the Breast, Ann. Surg. **125**: 673, 1947.

11. Desaive, P.: Le cancer mammaire bilatéral, J. radiol. et électrol. **30**:335, 1949.

12. Clifton, E. E., and Young, L. E.: Carcinoma of the Breast, Am. J. Surg. **82**:158, 1951.

13. Brachetto-Brian, D.; Moguilevsky, L., and Itre, H.: Cancer bilateral de la mama, Prensa méd. argent. **38**:2268, 1951.

14. Keyes, E. L.; Jordan, E. J., and Wyatt, J. P.: Cancer of Both Breasts: 53 Case Reports, J. Missouri M. A. **49**:385, 1951.

15. Reese, A. J. M.: Bilateral Carcinoma of the Breast, Brit. J. Surg. **60**:428, 1953.

16. Guiss, L. W.: The Problem of Bilateral Independent Mammary Carcinoma, Am. J. Surg. **88**: 171, 1954.

17. Warren, S., and Gates, C.: Multiple Primary Malignant Tumors, Am. J. Cancer **16**:1358, 1932.

18. Harrington, S. W.: Results in Surgical Treatment of Carcinoma of the Breast in Women, J. A. M. A. **148**:1007, 1952.

19. Bloom, H. J. G.: Prognosis in Carcinoma of the Breast, Brit. J. Cancer **4**:259, 1950.

20. Bloom, H. J. G.: Further Studies on Prognosis of Breast Carcinoma, Brit. J. Cancer **4**:347, 1950.

21. Abel, S.: Androgenic Therapy in Malignant Disease of the Female Genitalia, Am. J. Obst. & Gynec. **49**:327, 1945.

22. Horsley, G. W.: Carcinoma of the Breast: Radical Mastectomy, Oophorectomy and Hormone Therapy, Virginia M. Month. **78**:226, 1951.

23. Smith, G. V., and Smtih, O. W.: Carcinoma of the Breast, Surg., Gynec. & Obst. **97**:508, 1953.

24. Sommers, S. C., and Teloh, H. A.: Ovarian Stromal Hyperplasia in Breast Cancer, A. M. A. Arch. Path. **53**:160, 1952.

25. Sommers, S. C.; Teloh, H. A., and Goldman, G.: Ovarian Influence Upon Survival in Breast Cancer, A. M. A. Arch. Surg. **67**:916-919, 1953.

Main Duct Papilloma of the Breast

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There is a form of polyp which usually occurs singly near the exit of a main lactiferous duct. It can be removed by local excision, like polypi in the nose, cervix, colon, and bladder; yet in the breast, as well as in other locations, it is important to search carefully for multiple lesions and to consider even this benign growth as a possible omen that the person will be more subjected to cancer than others who are free of any polyp.

This paper reviews and illustrates a method of recognition and treatment of these rare lesions which has proved worthwhile in a series of 30 patients, 24 of whom were followed from 5 to 16 years. None of the entire group has developed carcinoma. All credit for originality in this method of management is given to others (Babcock,[1] Wakeley,[2] Chester and Bell,[3] and Haagensen, Stout, and Phillips[4]), who have pioneered this subject in our time. This paper also attempts to judge the validity of this method of management by analyzing all cases with a diagnosis of papillary disease discharged from the Hospital of the Good Samaritan between the years 1922 and 1949. From a consecutive series of 2915 breast tissue specimens, 135 were found with papillary disease. One hundred seven, or 79% of these, were followed 1 to 30 years, with an average follow-up of 10 years.

RECOGNITION

In all of the 30 patients in whom the condition is believed to be confined to a main duct, the disease was suspected from a history of discharge from the nipple or because of a superficial mass located in the nipple area, or because of both. The discharge was almost always bloody or contained red cells on microscopic study. Other specific diagnostic aids, such as mammography (Hicken[5]) and special stained studies of the discharge (Jackson and Severance[6]), have not been used.

LOCALIZATION

As the 16 to 20 lactiferous ducts radiate outward from the nipple, the solitary polyp is found in or near the ampulla of the duct, beneath the areola (Fig. 1). With the patient lying down, the nipple area is flattened by spreading the tissues with the index finger and thumb of the left hand and pressing toward the nipple at the periphery of the areola (Fig. 2). At the same time the outlet secretion (Fig. 3). This observation is aided of the duct on the nipple is observed for by magnifying glasses for identification of the single duct involved (Fig. 4). If, in addition to the discharge, a small mass is present in the area (Fig. 5), the diagnosis and localization of the lesion are clear. It is always necessary to have the patient return for repeated examinations to be entirely sure that the duct containing the papilloma can be identified before surgery and that there are not multiple lesions producing the discharge.

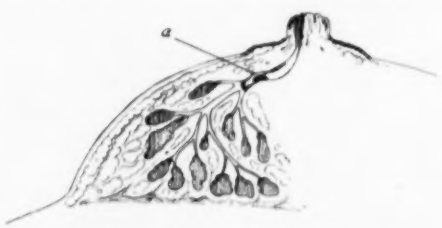

Fig. 1.—This is a diagrammatic sketch of the whole breast in cross section, showing the distribution of one of the 16 main lactiferous ducts with the polyp (*a*) in the usual location of the main duct beneath the areolar margin.

From the Hospital of the Good Samaritan and the University of Southern California School of Medicine at Los Angeles.

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

Fig. 2.—The surface of the breast is spread out. Pressure is exerted in the direction of the nipple with the index finger placed at the periphery of the areola.

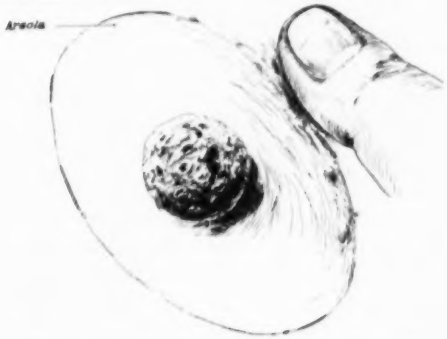

Fig. 3.—The openings of the ducts on the surface of the nipple are shown, reduced to ⅔ of mag. × 4. A drop of blood is indicated as coming from the main duct being pressed upon by the finger.

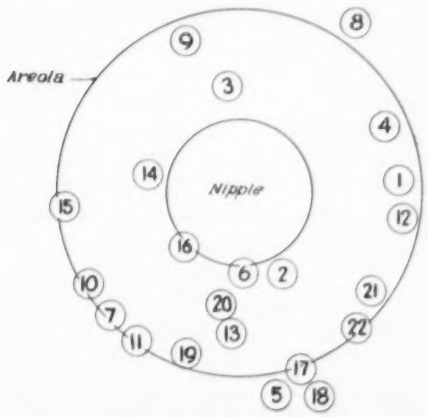

Fig. 4.—The small circles indicate the location beneath the nipple and areola in which 22 cases of main duct papilloma were localized by the pressure technique described.

Fig. 5.—The areola and nipple are shown. All masses were small and located in the areas indicated. They were usually superficial.

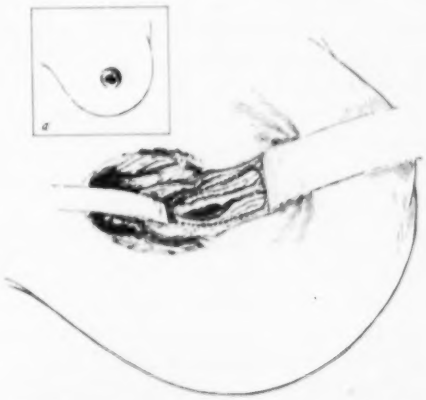

Fig. 6.—The insert (*a*) shows the line of incision at the periphery of the areola extending nearly half way around the circumference. In the main drawing, the duct containing the papilloma has been exposed and the dotted line indicates the area to be excised which includes surrounding breast tissue for biopsy.

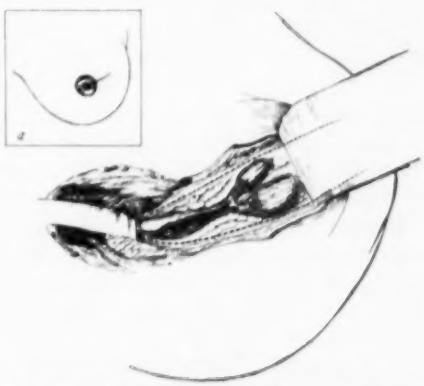

Fig. 7.—The insert indicates spokewheel extension of the circumareolar incision which allows exposure and complete removal of the entire segment of breast tissue drained by the single duct involved, shown in the main diagram.

SURGERY

A circular incision is made at the periphery of the areola (Fig. 6). The skin, subcutaneous tissue, and breast capsule are incised and reflected to the nipple and laterally over the breast tissue as far as possible. The duct with the dilated area which is slightly discolored is identified and opened longitudinally, making positive the presence of the papilloma. A wedge-shaped section of breast tissue including the duct is then removed. Occasionally because the entire duct and its branches are dilated or filled with blood, the whole lobe drained by the duct must be removed (Fig. 7). This is accomplished by adding a spokewheel incision and resecting a wide pie-shaped section of the entire breast tissue drained by the main duct system involved.[7] The wound is closed subcutaneously with a Penrose drain.

PRECAUTIONS

It is important to identify the single main duct involved before surgery. If several separated main duct systems show discharge on pressure, the procedure should not be attempted. It is important to identify the duct, verify the presence of the papilloma, and remove the duct and a wide section of breast tissue for microscopic assay. Within the surrounding breast tissue biopsy specimen may be included any of the benign or malignant lesions. Occasionally frozen section will be positive, but a final decision usually must be made after paraffin section.

It is important not to lump together main duct polyps with other breast lesions which may be associated or coexist. Every effort should be made to eliminate more important conditions, and the patient must be informed that radical procedure may be decided upon at surgery. However, the woman who has a benign polyp of a lactiferous duct is entitled to have it removed and is fortunate to have, in addition, a generous biopsy of the remaining breast tissue for pathological opinion and prognostication.

It is clear that under the conditions of this clinical experience the method proposed is thus far satisfactory (Table 1). However, some of the other carefully conducted clinical studies have found the incidence of recurrence (Table 2) and cancer (Table 3) much higher. The varying experiences of other investigators in this field account for the differences in proposed treatment.

TABLE 1.—*Summary of Thirty Cases of Main Duct Polyp* *

1.	Main duct and papilloma identified and excised
2.	Biopsy of surrounding tissue benign
3.	Recurrence, benign lesion same breast, 1 case
4.	Carcinoma same breast, 0; opposite breast, 1
5.	Follow up 100% 1-16 yr., average 7½ yr.

* Symptoms and physical findings in these cases consisted of nipple discharge alone in 22, superficial mass near the nipple in 13, mass and discharge in 8, mass alone in 7. The one recurrence was seven years later and consisted of chronic cystic mastitis.

TABLE 2.—*Papillomas Locally Removed—Recurrence Same Breast* *

Author	No. of Cases	Recurrence No.	Recurrence %	Follow-up, Yr.
Estes & Phillips [5]	34	4	11.7	5
Marshall & Mareum [9]	52	8	15.3	1-13
Haagensen, Stout, & Phillips [4]	69	4	5.8	10+
Lewison & Lynes [10]	32	2	6.3	11 (av.)
Shie [11]	27	1	3.7	4
Hart [12]	66	9	13.6	1-22
Geschickter [13]	56	8	14.3	3-35
Greenough & Simmons [14]	10	2	20.0	4
Chester & Bell [8]	53	2	3.7	5
Present series	30	1	3.3	1-16
Total	429	41	9.5	

* From accumulated studies, it can be seen that after local removal of a papilloma, recurrent trouble can be anticipated in the same breast in 1 out of 10 operated breasts.

TABLE 3.—*Carcinoma After Local Removal of Papilloma* *

Author	Cases	Cancers, No.	Follow-up, Yr.
Geschickter [13]	54	3	3-35
Warren [17]	21	3	5-21
Toronto series [17]	71	2	5-21
Donnelly [18]	7	3	1-13
Kilgore, Fleming, & Ramos [16]	57	6 same 2 opp.	2-5
Marshall & Mareum [9]	58	0	1-13
Hart [12]	22	1	1-22
Chester & Bell [8]	20	0	5
Haagensen, Stout, & Phillips [4]	72	0	5-21
Lewison & Lynes [10]	32	0	5-25
Fitts, Maxwell, & Horn [15]	46	1	Not given
Present series	30	1 opp.	1-16
Total	490	19	

* Expectation of the development of cancer following local excision of papilloma, in a compilation of reported series, is 1 in 25. It must be realized, however, that "carcinoma in situ," often included in cancer totals, is probably of much less serious import.

Papillary disease of the breast refers to a morphological classification including any condition with branching connective tissue stalks covered with epithelial cells. This paper emphasizes one such benign type in which a polyp or papilloma is formed in the main duct that can often be recognized clinically and removed locally. Cystic masses located near the nipple may contain blood occasionally and a fleshy mass and can be recognized as papillary cysts by the surgeon. Under other circumstances, microscopic examination of the tissue removed is necessary to bring the correct diagnosis to the surgeon's attention. The significance of the microscopic morphological findings of papillary disease are studied in the following manner.

TABLE 4.—*Types of Papillary Disease in 135 Cases* *

Entity	Cases, No.	Follow-up: Cases, No.	Follow-up: Years	Follow-up: Av., Yr.
1. Main duct polyp †	44	38	1-16	8
A. Typical 30 (solitary, as described)				
B. Atypical 14 (multiple, or masteetomy)				
2. Cystadenoma, papilloma	6	5	3-15	10
3. Duct papillomatosis, with cystic mastitis	53	41	4-16	8
4. Papillary carcinoma in situ	24	18	3-30	12½
5. Infiltrating carcinoma	8	5	5-19	9
A. Papillary cancer 2				
B. Assoc. papilloma 6				
Total	135	107	1-30	10

* This classification is a guide for the surgeon. He must locate the main duct polyp and can suspect the cystadenoma from its gross appearance; microscopic study alone can disclose the remaining types of papillary disease. In no case in which infiltrating carcinoma was not found at the original surgery is carcinoma known to have developed in the same breast in this series.

† Six cases only in this group were followed less than five years.

MATERIAL

From a series of 2915 sections of breast tissue obtained during the years 1922-1949, at the Hospital of the Good Samaritan, in Los Angeles, the diagnosis of papillary disease was included in the day book diagnoses in 135 cases, or in about 5% of all breasts studied by the pathologist. Each slide was reviewed and catalogued by the authors. All case records were abstracted and an exhaustive follow-up study instituted. One hundred seven cases, or 79% of the total series, were finally located and followed for from 1 to 30 years, with an average of 10 years.

TYPES OF PAPILLARY DISEASE

The types of papillary disease considered in this paper are tabulated in Table 4. These have been listed from the surgeon's standpoint. No pathological discussion of this intricate and fascinating subject will be attempted except as it is related to the surgeon's approach. If the microscopic findings indicate the presence of a duct papilloma, cystadenoma, papillomatosis, the surgeon may be satisfied with a local excision and close follow-up examinations of his patient. However, many (Kilgore and co-workers,[16] Estes and Phillips,[8] and Donnelly [18]) favor simple mastectomy. If, on the other hand, severe atypical hyperplasia, precancerous hyperplasia (Cole and Rossiter [20]), carcinoma in situ, intracystic papillary carcinoma Grade 1, or noninfiltrating duct carcinoma is diagnosed, almost all surgeons are agreed that the least one can do is a simple mastectomy. Follow-up studies, such as this, on these boderline lesions must be accumulated so that the pathologist can predict the possibilities of axillary metastases and the surgeon can know whether or not a simple mastectomy is safe and, therefore, preferable to a radical procedure.

1. The typical main duct papillomas have been described earlier in this paper. Fourteen cases in which several main ducts were involved or in which the surgeon did not expose the duct or find the polyp were considered atypical. The two cases with multiple main duct involvement required further surgery. In four cases with local excision without exposure of the duct, two recurred. Nine cases had initial mastectomy, without further trouble.

2. Cysts are, strictly speaking, globular fluid-containing structures separate from the duct system.[19] If they are large (1.5 cm. or more) and contain papillary or adenomatous growths, they are termed papillary cystadenomas. By careful gross dissection, connection with the duct system can be excluded, or microscopically this can be decided, with certainty, only by serial section. In a single section cysts and dilated ducts appear alike. For this reason the term intracystic papilloma and intraductal papilloma are often used in-

terchangeably. In six true benign cysts in this series, three were locally excised and mastectomy was performed in three. There were no recurrences.

3. Duct papillomatosis simply means that papillary processes are present in many ducts. The presence of a papillary process extending into a few large ducts can be considered as an intraductal papilloma or as papillomatosis and, at the other extreme, all ducts on the slide may show papillary processes and then the condition should no longer be considered as a duct papilloma. It is strictly a microscopic diagnosis. Main duct papilloma, on the other hand, is best recognized by careful gross dissection by the surgeon or pathologist. Papillomatosis was discovered in the 53 cases reported because breast biopsies (35 cases) or mastectomy (18 cases) were performed by the surgeon for nipple discharge (5 cases) or for the presence of a mass (45 cases), and there were 3 cases with both. It was accompanied by, or a part of, some form of chronic cystic mastitis [24] in 43 cases. The significance of the finding of papillomatosis to the surgeon is, as yet, undetermined, and so it is infrequently recorded in the final diagnosis by the pathologist. In a classic study by Foote and Stewart [19] of 500 breasts, 200 benign and 300 malignant, it was found in 29% of the benign group and 36% of the malignant series. The recurrence of trouble in the breasts in which the finding was recorded in the cases reported in this series was 9%. No carcinomas are known to have developed during an average period of 10 years.

4. Papillary carcinoma in situ is a term recently applied to certain breast lesions.[21] In this article it is used to include severe grades of atypical hyperplasia, precancerous lesions, borderline cancers (Bloodgood [23]), debatable carcinoma,[16] papillary adenocarcinoma Grade 1 noninfiltrating, and early low-grade carcinoma. Again it is pointed out that this discussion is for the surgeon, in an effort to understand better the pathological picture portrayed in different ways, using different terminologies. Recognition of cancer cells when they are confined to ducts may enter a "shadow land" even for the most experienced pathologist.[22] When these cells have spread into the surrounding breast tissue, no doubt exists.

The 24 cases here recorded were reappraised by the pathologists of the Hospital of the Good Samaritan * and the authors, and though many were considered to be true cancer yet in none could infiltration or invasion of surrounding breast tissue be demonstrated clearly in the sections studied.

These cases were variously treated: local excision, 3; simple mastectomy, 13; radical mastectomy, 8. The follow-up study was 75% complete and ranged from 3 to 30 years. No case followed showed evidence of carcinoma developing in or from the breast operated upon.

5. The eight cases of infiltrating carcinoma were discovered at surgery with frozen section, or, later, by paraffin section, and in all a radical mastectomy was performed. Five have been followed 5 to 19 years and are living and well. Three are lost to follow-up. Two had infiltrating papillary carcinoma. In six, severe papillary disease was found in conjunction with an undifferentiated carcinoma. In none had previous breast surgery been done.

COMMENT AND SUMMARY

This paper has considered duct papilloma of the breast from the surgical standpoint. If a papilloma can be demonstrated grossly in a main duct, the condition is referred to as main duct papilloma. If the papillary process is confined to a globular structure isolated from the duct system, it is considered as a papillary cystadenoma. If multiple ducts are involved (a microscopic diagnosis), the condition is termed papillomatosis. If, histologically, there is severe atypical hyperplasia, precancerous hyperplasia, borderline cancer, debatable cancer, noninfiltrating Grade 1 papillary carcinoma, or duct carcinoma confined to ducts in the sections examined, it has been referred to as carcinoma in situ. If infiltration has occurred, it is unreservedly called cancer.

The material for this study was drawn from 2915 specimens of breast tissue ex-

amined by the pathologist at the Hospital of the Good Samaritan from 1922 through 1949. One hundred thirty-five cases of papillary disease, as above described, were completely restudied, and 107 of these, or 79%, were successfully followed for a period of from 1 to 30 years, an average of 10 years. No case was found who died of carcinoma arising from the breast operated upon in which an infiltrating carcinoma had not been discovered at the original surgery. This circumstance is at variance with other studies in the literature, and no conclusions should be drawn from it; however, it has given some backing to the faith of the authors in continuing to recommend the method described and illustrated in 30 cases of locally removed main duct papillomas.

In brief, the method (in no part original) consists in localizing the main duct harboring the papilloma, in exposing and identifying the duct and lesion, in excising the duct and a wide margin of breast tissue, and in evaluating the specimen microscopically for a precancerous or cancerous lesion. With these precautions followed and the patient kept under observation, we prefer this treatment for most women rather than a more radical procedure.

* Dr. George Maner and Dr. Raymond Bangle Jr. aided in the reappraisal of these cases.

REFERENCES

1. Babcock, W. W.: A Simple Operation for the Discharging Nipple, Surgery **4**:914-915, 1938.

2. Wakeley, C. P. G.: Duct Papillomata of the Breast: A Plea for Conservative Therapy, Brit. M. J. **1**:436-437, 1945.

3. Chester, S. T., and Bell, H. G.: Intraductal and Intracystic Papilloma of the Breast, West. J. Surg. **49**:603, 1951.

4. Haagensen, C. D.; Stout, A. P., and Phillips, J. S.: The Papillary Neoplasms of the Breast, Ann. Surg. **133**:18-36, 1951.

5. Hicken, N. F.: Mammography: Roentgenologic Diagnosis of Breast Tumors by Means of Contrast Media, Surg., Gynec. & Obst. **64**:593-603, 1937.

6. Jackson, D., and Severance, A. O.: Cytological Study of Nipple Secretion, Texas J. Med. **41**: 512, 1946.

7. Cheatle, G. L., and Cutler, M.: Tumors of the Breast, Philadelphia, J. B. Lippincott Company, 1931, p. 107.

8. Estes, A. C., and Phillips, C.: Papilloma of Lacteal Duct, Surg., Gynec. & Obst. **89**:345, 1949.

9. Marshall, S. F., and Marcum, R. W.: Papilloma of Lacteal Ducts of the Breast: Report of 100 Cases, S. Clin. North America **31**:869-876, 1951.

10. Lewison, E. F., and Lynes, J. G., Jr.: Relationship Between Benign Breast Disease and Carcinoma, A. M. A. Arch. Surg. **66**:94-114, 1953.

11. Shie, E.: On the Prognosis of the Papilloma of the Lactiferous Ducts, Acta chir. scandinav. **87**: 417-432, 1942.

12. Hart, D.: Intracystic Papillomatous Tumors of the Breast, Benign and Malignant, Arch. Surg. **14**:793, 1927.

13. Geschickter, C. F.: Diseases of the Breast, Philadelphia, J. B. Lippincott Company, 1943, p. 349.

14. Greenough, R. B., and Simmons, C. C.: The Results of Conservative Therapy of Cystic Disease of Breast, Ann. Surg. **60**:42, 1914.

15. Fitts, W. T., Jr.; Maxwell, J. D., and Horn, R. C.: Significance of Nipple Discharge, Ann. Surg. **134**:29-39, 1951.

16. Kilgore, A. R.; Fleming, R., and Ramos, M. M.: Incidence of Carcinoma with Nipple Discharge and Risk of Carcinoma in Presence of Papillary Disease of the Breast, Surg., Gynec. & Obst. **96**:649-660, 1953.

17. Warren, S.: Relation of "Chronic Mastitis" to Carcinoma of the Breast, Surg., Gynec. & Obst. **71**:257-273, 1940.

18. Donnelly, B.: Nipple Discharge: Its Clinical and Pathological Significance, Ann. Surg. **131**:342-355, 1950.

19. Foote, F. W., and Stewart, F. W.: Comparative Studies of Cancerous Versus Noncancerous Breasts, Ann. Surg. **121**:6-53; 197-222, 1945.

20. Cole, W., and Rossiter, L. J.: Chronic Cystic Mastitis with Particular Reference to Classification, Ann. Surg. **119**:573-590, 1944.

21. Foote, F. W., and Stewart, F. W.: Lobular Carcinoma in Situ, Am. J. Path. **17**:491, 1941.

22. Foote, F. W., and Stewart, F. W.: A Histologic Classification of Carcinoma of the Breast, Surgery **19**:74-99, 1946.

23. Bloodgood, J. C.: Borderline Breast Tumors, Am. J. Cancer **16**:103, 1932.

24. Snyder, H. E.; Snyder, C. D., and Grosjean, W. A.: Benign Lesions of the Breast, South. Surg. **16**:555-568, 1950.

Routine Aspiration of Discrete Breast Cysts

Report of Two Hundred Sixty-Seven Breast Aspirations

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One of the most satisfying experiences, for both surgeon and patient, is the withdrawal of a small amount of cloudy fluid from a discrete mass in the breast followed by the discovery that the lump which had terrified the patient has completely disappeared. Breast cyst aspiration is a safe, painless, inexpensive way to differentiate a benign breast lesion from a potentially malignant one. It shows immediately whether the lesion is really cystic and not dangerous or solid and possibly malignant. If a cancer should be growing inside the cyst, aspiration would reveal the presence of bloody cyst fluid. If a cancer should grow in the cyst wall rather than in the cyst lumen, withdrawal of the cyst fluid not only would fail to make the mass disappear, but it would make the nodularity of the cancer more apparent. In addition to these diagnostic advantages of breast cyst aspiration, there is a very real likelihood that the simple procedure of aspiration will prove curative, thus preventing an unnecessary operation. This happy result is caused by the fact that in many instances discrete breast cysts have little or no epithelial lining; thus when the fluid is removed, the collapsed cyst walls grow together and the cyst is obliterated.

All the patients of this series were told that solid breast tumors must be removed, but that many cystic breast tumors can be cured by aspiration. It was made very clear that if aspiration yields no fluid, or if the fluid is bloody, or if the fluid returns promptly, or even if the mass does not completely disappear with the aspiration, then excision of the area must be carried out. Once these facts were understood and the patient agreed to return in four weeks for final appraisal of the results obtained by aspiration, the cyst was aspirated then and there in the office.

The technique of breast cyst aspiration is simple. A bleb of 1% procaine is raised in the skin over the cyst; then with the use of a No. 20 gauge needle with a short bevel and a syringe that is larger than the estimated fluid content of the cyst, the cyst is aspirated. Care should be taken to stop the introduction of the needle as soon as it is felt to enter the cyst so that the point will not scratch the posterior wall of the cyst and produce bleeding. Also, care should be taken to empty the cyst completely by external pressure while suction is made with the syringe. When the cyst seems to be deep in the breast tissue, it is advisable to use a lumbar puncture needle with its stylet in place during the introduction of the needle. This prevents the needle from becoming occluded by a plug of breast tissue before reaching the cyst.

This report is based upon the analysis of 267 breast aspirations, carried out for 202 consecutive women thought to have a definite discrete cystic lesion of the breast. Areas of multiple or conglomerate cyst formation and masses thought to be solid were excised without aspiration. There were 210 successful aspirations yielding fluid and 57 dry taps in which no fluid was obtained. All of the masses which yielded no fluid were considered solid and prompt excision advised in every instance. Forty of the 57 dry taps were found to be some form of benign lesion, such as soft fibro-

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adenoma or adenosis or lipoma. In five instances the breast mass was aspirated and no fluid was obtained, but before the patient could be operated upon the mass completely disappeared. It is possible these patients had areas of mazoplasia which became soft owing to changes in the menstrual cycle, or possibly a cyst was punctured and the fluid leaked out of the cyst and was absorbed. It was felt that five patients with cancer were brought to radical operation earlier because prompt aspiration of a cystic-feeling mass yielded only a few drops of bright blood. This proved the lesions to be solid ones demanding immediate excision. A policy of waiting for the mass to change in response to hormone therapy would have brought only delay in the treatment of these apparently cystic lesions.

TABLE I.—*Classification of Fifty-Seven Unsuccessful Breast Aspirations*

Classification	No. of Cases
Fibroadenoma	14
Adenosis or mazoplasia (5 thick-walled cysts)	24
Lipoma	2
Carcinoma	5
Mass disappeared before excision	5
Lost to follow-up	7
Total	57

The youngest patient in this series of 210 breast cysts was 21 years old, and her cyst was a galactocele; the youngest patient showing the usual form of cystic disease of the breast was 30 years old. The oldest patient was 62 years old and gave a history of many years of estrogenic therapy prior to the development of her cyst. There were six such elderly patients with cysts, and three of them had received large doses of estrogens. In general, however, hormone therapy did not seem important in the etiology of breast cysts.

Analysis of the historical data revealed that patients with a discrete cyst of the breast sought relief soon after the cyst was noticed. One hundred fifty-four of the 210 cystic lesions had been noticed two months or less. A little more than half of the patients stated that the cysts were painful. Only a few patients could remember any significant trauma to the breast. In this series lactation or absence of lactation did not seem to play an important role in the development of breast cysts. Patients with breast cysts did seem more likely to have a long history of breast disorders of various sorts. Eighty-five patients reported removal of a benign breast lesion by excision or aspiration; six reported radical mastectomy of the opposite breast, and three patients had had simple mastectomy prior to our breast-cyst aspiration.

The cysts chosen for aspiration were usually solitary cysts (129) and more rarely (81) multiple, but they always seemed fluctuant or springy on palpation. Areas thought to be solid were excised and not aspirated. The aspirated fluid was usually turbid greenish or amber-colored. It varied in amount from 0.5 to 50 ml., the average being 8.1 ml. The mass completely disappeared after 206 of the 210 aspirations. The remaining four cysts became smaller, but nevertheless the residual thickness was immediately excised. The thickness proved to be small areas of mazoplasia about the larger aspirated cyst.

The only ill effect or complication encountered in this series of 267 breast aspirations was intracystic bleeding, which was probably caused by the aspirating needle. The hemorrhage caused the cyst to refill promptly. Hemorrhage into a cyst can be suspected if the puncture wound in the skin bleeds excessively. Of the 210 cysts which were aspirated, 5 promptly filled with bloody fluid after their aspiration. Three of these were excised and showed blood clots inside the cyst. The other two disappeared before they could be excised. In these, apparently the bloody fluid leaked out into the tissues about the cyst and was absorbed.

Because aspiration was not carried out unless the patient agreed to return in one month for reexamination, follow-up studies are complete (100%) for 210 consecutive breast cyst aspirations that form the basis for this report. The minimum follow-up period of one month is adequate to evaluate the procedure, because if an emptied cyst is destined to refill, in the great majority of instances it does so within

one month. Six of the 12 cysts that refilled did so within less than one month. In fact, reexamination after several months is unreliable, because it is very difficult to be sure whether the mass felt is a refilling of the aspirated cyst or a new cyst formed nearby. Since we have been routinely aspirating breast cysts only four or five years, we do not have late follow-up results for the procedure. However, Patey and Nurick [1] followed 33 patients for five or more years after breast-cyst aspiration. Only one cancer developed in this group, and it came in the opposite breast three years after aspiration of multiple cysts in the first breast. Vanden Berg [2] reported on 57 patients followed an average of seven and one-half years after aspiration of a breast cyst. Of these one developed cancer, and it was in the opposite breast and not associated with any demonstrable cysts.

TABLE 2.—*Follow-Up Data on 210 Consecutive Breast Cyst Aspirations*

Time Followed, Mo.	Aspirations, No.*	Apparently Cured by One or More Aspirations, No.	Cyst Refilled, No.	Residual Mass After Aspirations, No.
1- 2.....	72	62	6	4
2- 6.....	34	32	2	..
6-12.....	19	16	3	..
12-24.....	59	58	1	..
24.....	26	26	0	..
Totals.....	210	194	12	4

* Eight cysts required two aspirations and one cyst required three aspirations for apparent cure.

One hundred ninety-four of the 210 aspirated cysts disappeared after one or more aspirations, and the aspirated area remained free of cysts from one month to several years. There were eight that required two aspirations and one that required three aspirations before the cyst could no longer be detected by palpation. It is rarely advisable to aspirate the same cyst more than two times. Sixteen cysts either refilled or the mass did not completely disappear with aspiration. All of these were excised. One of these was a galactocele. Seven cysts were found to be partially lined by low epithelium or to have no demonstrable epithelial lining. Seven cysts showed clusters of small cysts in the large cyst wall. One cyst was completely lined by epithelium or papillary projections, but the process was not considered malignant.

COMMENT

Those who fear routine aspiration and favor excision of all breast cysts do so because they feel that unless all such lesions are excised an intracystic cancer might be overlooked. We do not believe the danger of overlooking an intracystic cancer is great enough to justify routine excision of every discrete cyst of the breast. The development of intracystic breast cancer must be a very rare occurrence. Adams [3] reports one instance of a cancer in a blue-domed cyst. Geschickter [4] in his book "Diseases of the Breast" followed 378 patients with cystic disease of the breast for an average of 10.2 years. He found the incidence of mammary cancer in this group to be twice that expected in the normal population. However, none of the four patients with cystic disease of the breast who developed breast cancer showed the cancer in the lumen or wall of a cyst. At Baylor University Hospital 281 carcinomas of the breast have been examined in the Department of Pathology in the last four years (Jan. 1, 1951, through Nov. 8, 1954). Only two intracystic carcinomas have been observed, and these were of the papillary type which causes bloody fluid in the cyst. It is felt that such cancers would be easily recognized either by the bloody fluid obtained at aspiration or by the fact that the mass did not completely disappear with removal of the cyst fluid. Since such findings on aspiration demand immediate excision of the cyst and surrounding breast tissue, an intracystic cancer should be diagnosed by aspiration at the earliest possible moment.

It has been stated that routine breast-cyst aspiration is undesirable because it would fail to disclose a small cancer that might be discovered nearby during a cyst excision operation. We hold that if a small cancer is detected during the removal of a benign breast cyst this must be considered a piece of rare good fortune for the patient rather than a probable oc-

currence. This opinion is based upon the fact that exploration of the breast is incomplete during cyst excision and the fact that there is no proof that cancer tends to develop in or near areas of breast-cyst formation. Also, it is well recognized that breast cancer ordinarily does not have a nearby cyst to direct attention to the cancerous area.

One of the most cherished hopes of those who favor breast-cyst excision as a routine is that by this procedure they are protecting their patient from the development of cancer in that area at some subsequent date. As the facts stand, a woman with a breast cyst is more likely to develop a mammary cancer than is a woman with normal breasts, but the cancer may develop in either breast and the surgical removal of a cyst offers her no protection. Small cysts or ducts filled with epithelium and small nodules of hyperplastic glandular tissue which may be found in both breasts are regularly left behind when a large cyst is removed. Such small nodules are more dangerous than the large cyst, which often shows no epithelial lining whatsoever. We have observed two patients who developed breast cancer beneath scars made 8 and 18 years previously for the removal of benign breast cysts. Shaver and Freeman [5] have reported a patient who returned for examination showing cancer growing under the scar left by the excision of an area of chronic cystic mastitis 11 years previously. Shields Warren [6] has analyzed the charts of 604 patients with chronic cystic mastitis, chronic mastitis, or adenocystoma. He concludes that a woman with any such lesion is four and one-half times more likely to develop breast cancer than she would have been had she not developed such pathological breast tissue. He also states that this susceptibility to breast cancer exists whether or not the recognized diseased breast tissue was partially or even completely removed by operation. Reasoning from such experiences, it would seem that excision of a breast cyst offers little or no protection against the subsequent development of mammary cancer.

Some surgeons object to the routine aspiration of breast cysts because they fear that such an easy solution to the problem might make a woman careless of any breast masses she might develop at some later date. We feel that a woman should not be made to suffer the pain and expense of an operative procedure just because she is unfortunate enough to have developed a breast cyst. Rather she should be protected from the inevitable fear that goes with every biopsy operation "to see if it is a cancer." Many of these patients come to the surgeon extremely frightened by either what they have read or what they have heard from the referring physician. A discussion about the value of an operation for biopsy, the operation for removal of the cyst, and then the waiting for the pathologist's report all add up to quite an emotional experience. In some introspective persons this could result in the development of an abnormal fear of cancer. It seems so much more reasonable to reserve breast-cyst excision with its attending fear, pain, and expense for the relatively few patients who are not cured by the simple procedure of breast-cyst aspiration.

SUMMARY

Two hundred two consecutive patients with a diagnosis of breast cyst received 267 breast aspirations.

There were 57 aspirations yielding no fluid; five of these lesions proved to be cancer.

Of the 210 aspirated cysts, 194 were apparently cured by the procedure.

Aspiration of a cyst should not be carried out more than two or three times.

Prompt excision should be advised for all cysts with bloody cyst fluid and for all cystic masses that do not completely disappear with removal of the cyst fluid.

REFERENCES

1. Patey, D. H., and Nurick, A. W.: Natural History of Cystic Disease of Breast Treated Conservatively, Brit. M. J. **1**:15 (Jan. 3) 1953.

2. Vanden Berg, H. J.: Diagnosis and Therapeusis of Simple Cysts of the Breast, Surg., Gynec. & Obst. **83**:239 (Aug.) 1946.

3. Adams, L. J.: Carcinoma in a Blue Domed Cyst of the Breast, Canad. M. A. J. **19**:190 (Aug.) 1928.

4. Geschickter, C. F.: Diseases of the Breast, Philadelphia, J. B. Lippincott Company, 1945.

5. Shaver, W. T., and Freeman, W. H.: Breast Cysts, S. Clin. North America **33**:1409 (Oct.) 1953.

6. Warren, S.: The Relation of "Chronic Mastitis" to Carcinoma of the Breast, Surg., Gynec. & Obst. **71**:257 (Sept.) 1940.

DISCUSSION

On Papers by Drs. Carroll and Shields; Chaffin and Snyder, and Goode, McNeill, and Gordon

Dr. E. Lawrence Keys, St. Louis: I want to thank Dr. Carroll for asking me to discuss his paper on bilateral simultaneous carcinoma of the breast and to congratulate him on obtaining an 11½-year survival of his patient with bilateral simultaneous mammary carcinoma following radical mastectomy. I believe the reason he asked me to discuss his paper is because I had occasion to publish a series of 53 bilateral breast cancers among 428 patients, which is an incidence of around 12%. However, of these, only two were of the simultaneous variety which Dr. Carroll discussed. I believe their case histories are not without interest.

Patient 1 was a man 49 years of age, who developed adenocarcinoma simultaneously in both breasts 33 years after x-ray treatment of his chest for eczema and 22 years after the removal of a tumor of unknown histology from his left nipple. Dr. W. Leighton did a bilateral simultaneous simple mastectomy with bilateral axillary dissection at Firmin Desloge Hospital and found the axillary nodes invaded on the right but not on the left. The patient died of metastases in his fourth postoperative year, and subsequently Dr. Leighton told me he operated upon the patient's grandmother for unilateral breast cancer at the age of 107.

Here were two points of interest: first, carcinogenesis from irradiation of breasts 33 years previously; second, a familial tendency toward breast cancer. Shields Warren considered even so small a dose as 1 skin erythema dose of radiation sometimes to be carcinogenic. Willis said: "Cases of bilateral mammary cancer occurred in four generations, including three sisters in one generation; the growths appeared at an average of 32, i. e., earlier than usual, and one patient in the fourth generation developed the disease at the age of 18."

Patient 2 was a woman of 47 who developed simultaneously adenocarcinoma in the upper outer quadrants of both breasts, upon whom Dr. E. J. Jordan operated by bilateral radical mastectomy, with six months between operations. Both axillae were invaded histologically, and she died of metastases six years later, despite irradiation.

The one woman I have seen with bilateral simultaneous mammary carcinoma was inoperable and was treated by x-ray only.

Simultaneous bilateral mammary carcinoma has occurred as a metastatic manifestation from adenocarcinoma primary in the rectum in a woman patient of Drs. Rifkin and Blumenthal, at Jewish Hospital.

As to the sequential variety of bilateral mammary carcinoma, we have published reports of 51 cases among a series of 428 unilateral cases, an incidence of about 12%. Up to 17 years have elapsed between cancer developing in one breast and then in the other. There were two varieties, the independent type, with but one focus of cancer in each breast, salvaged for five years in 5 of 12 patients following bilateral radical mastectomy, and the metastatic type, with foci of cancer in both the breasts and elsewhere, not salvaged for as long as five years in any patient, calculating times after the second mastectomy.

For an unusual type of sequential bilateral carcinoma occurring in supernumerary breasts I have operated upon a woman of 40, the second radical operation performed one year after the first, with death of the patient after eight years from cancer of the uterus.

Dr. Herbert H. Davis, Omaha: I should like to make a few remarks on all three papers.

My series of one case of bilateral simultaneous carcinoma of the breast was a woman aged 54, upon whom I operated on Oct. 28, 1948, six years ago. She had comedocarcinoma of the right breast and scirrhous carcinoma of the left breast. No axillary nodes were involved on either side. She had postoperative x-ray therapy, and she is perfectly well at the present time.

[Slide] In regard to Dr. Snyder's paper on mainduct papilloma of the breast, may I say that in a series of 651 patients in 14 years, in my private practice, on whom I did breast operations of different kinds, 20 operations were for papilloma of the breast. This slide shows their age group. We seem to get one peak along premenstrual age and another group after menopause. There were 10 before menopause and 10 after menopause.

[Slide] Here is the group of all the cases, showing that 40% of the entire group had carcinoma, 34% cystic disease, 14% adenofibroma and 3.1% papilloma. You see this papilloma is at all ages with just a very small percentage all the way. We had 7.8% with miscellaneous disease.

Frank Adair, 20 years or so ago, reported that papilloma of the breast was dangerous in regard to its becoming malignant. A couple of years ago Haagensen came out with a very fine article giving the same type of results as Dr. Snyder has just

reported. He suggested that you do a biopsy and if it is benign, it usually stays well. In my 20 cases, some of them in earlier days, I did a simple mastectomy. Since then I have done simple excision of the area. When you press on it the blood comes from the nipple. None of my patients has had carcinoma.

Because of this difference of opinion, last February when I was visiting in New York I stopped at Memorial Hospital to see what they thought, and I talked to Fred Stewart and Dr. Foote, their two pathologists. They do not feel now that the lesion is dangerous in regard to carcinoma. Haagensen I also visited, and of course he said the same thing that he has reported in his article.

[Slide] I reported this past summer at the meeting of the American Medical Association on cystic disease of the breast. There are two schools of thought, one feeling that cystic disease is a very definite precancerous lesion. Others feel that it is not so dangerous.

Whether you wish to criticize me or not, I did just local excision, mainly unilateral. Occasionally there was a cyst in each breast, but I did local excision only in 92% of these cases. You can see that out of this series of 286 patients there were 4 who developed carcinoma. One has died of the carcinoma. It developed in the opposite breast and was a different type of carcinoma—a scirrhous carcinoma. Two of the others we know to be well after radical mastectomies, and one we have lost track of.

[Slide] This is diffuse-duct papillomatosus, in contradistinction to the main-duct papilloma. This shows what we mean by that term.

[Slide] This is the table of results. We divided those into cases of different degrees, and we found that only seven recurred and in only one carcinoma of a very mild degree developed. Of the extensive cases, in none did carcinoma develop.

[Slide] More extensive duct hyperplasia, like this.

[Slide] Seventy-five per cent of those remained well, with no recurrence, and only 1 of the group of 27 patients developed carcinoma.

In the discussion of this series I was surprised to hear the number of discussors who felt as Dr. Goode has reported, namely, that many were advising aspiration of single cysts. The discussion turned more that way than the other way. I am doing more aspirations. I have not had any of those cases, and we have not gotten into trouble with them.

I talked to the men at Memorial Hospital about it, and they feel that cystic disease has very little connection with carcinoma. When there is a lump they can aspirate, they do that and nothing else. Haagensen says, "I do a biopsy the first time, and if they have recurrences I do simple aspiration."

I think we can sum this up by saying that simple aspiration is fairly safe if you go by the points that Dr. Goode gave—that the lump should completely disappear and not recur and that one should obtain clear fluid and not bloody fluid.

Dr. Claude J. Hunt, Kansas City, Mo.: I wish to confine my remarks to the presentation by Dr. Carroll.

Dr. Carroll is a new member of this Association, and he has been very active in his scientific presentations. It shows very well the wisdom of the Council in selecting men for membership who contribute to the program.

I wish to report two cases of simultaneous carcinoma of the breast. One patient, 56 years of age, we operated on in April of this year for a bilateral simultaneous carcinoma of the breast. She had a type of fungating carcinoma on one side and a nodular mass of malignant character on the other side. The operations were done at a one-week interval, and the diagnosis by the pathologist was scirrhous Grade 3 carcinoma. One of the specimens had 12 metastatic glands and the other had 1. It is now two years since the operations, and so far she is in good condition.

The other case was that of a 66-year-old woman, who in 1952 presented herself with bilateral nodes in both breasts. This was preoperatively diagnosed as a bilateral simultaneous carcinoma. She had a bilateral radical mastectomy at an interval of a week to 10 days. One was a scirrhous carcinoma and the other was a ductile carcinoma, Grade 2. She had malignant glands in both axillae.

About a month after discharge from the hospital she returned with a mass in the right side, a history of pain, fever, and an increased leucocyte count. We assumed that she had an appendiceal abscess. We drained the abscess, which contained a considerable amount of pus. The appendix was removed. It did not appear to be acutely inflamed. The diagnosis was subacute appendicitis, which apparently was not the cause of the abscess.

She was informed that this mass might be malignant and after a period of time she should have the mass removed. We did not do it at the time of operation because of the presence of the infection.

She left our observation after a few visits to the office in March, 1952, and she did not return until September, 1952, at which time she still had a persistent draining sinus and a very definite hard mass which had infiltrated the abdominal wall. We did an exploratory operation and a right cholectomy. The liver had many metastatic nodules, and we removed a portion of her abdominal wall because of invasion of cancer. This was an adenocarcinoma of the cecum. She died within less than a year from abdominal carcinomatosus.

We believe this was a bilateral carcinoma of the breast with a simultaneous carcinoma of the cecum,

because within less than a month after the radical operations for the malignant disease of the breasts she returned with this abscess which we assumed was an appendiceal abscess and which subsequently was proved to be carcinoma.

Three distinct cancers of different character were present, illustrating that patients may have multiple simultaneous cancer.

Something has been said about surgery in the aged. These old people often withstand surgery with remarkable success. All of you have had much experience with surgery in the aged. Recently, we have had two rather remarkable experiences with persons who were very old who withstood radical surgery effectively.

Last year we did two radical mastectomies for carcinoma in very old persons, one in a woman 90 years of age and the other in a patient 96 years old. Both made excellent surgical recoveries.

Mr. Toby Levitt, Chicago: Please forgive me if I am rather curious. This curiosity is based solely on my ignorance.

I followed very closely the papers by Drs. Carroll, Snyder, and Goode, and I admire them because they are very useful and point in certain directions, but there were some problems which I could not solve.

First, could the speakers or any other member in the audience who has been faced with this problem of synchronous symmetrical carcinomata of the breast tell me whether they have been able to do antemortem studies of the patient and noted any endocrinological correlation between the breast and the rest of the organs?

Second, on postmortem examination have they been able to study the pituitary and the target endocrine glands, the thyroid, the adrenals, the gonads, and the secondary sex organs, and note whether there was any macroscopic or microscopic evidence which could give a lead to the solution of this difficult problem?

Third, I think it was Dr. Carroll who did oophorectomies. Did he note any correlation between the ovaries, macroscopically or microscopically, and the breasts and the other glands?

Futhermore, the problem of epithelial change perplexes me tremendously. I have recently come from the Growth Hormone Conference in Detroit and the Inter-Society Cytology Conference at Boston. There was great perplexity and a great worry at those Conferences. I asked them specifically at the Cytological Conference before they went into the panel discussion, and no pathologist could give me a specific definition, what was epithelial hyperplasia, what was epithelial dysplasia, whether mild, moderate or severe, what was carcinoma in situ, and what was invasive carcinoma. Each one had his own definition.

Until we all come to a common opinion on this matter we shall never be able to talk the same language, and our figures will always differ.

Furthermore, I think we should focus our attention more on effect than cause. We should shift our horizons higher than the target endocrine glands and shift it to the pituitary, and more so to the hypothalamus, because there, I believe, lies part of the solution to the problem.

Until we study the growth hormones and study its proliferative effects, and not when and how it runs riot, we shall never solve this problem.

Dr. Lawrence Chaffin, Los Angeles: I know the hour is late, Mr. President and members, so I will make my remarks very brief.

I should like to offer an excuse or an explanation for this small paper by Dr. Snyder and myself, because, going over the country, I find that simple mastectomy is a very common treatment for what we consider simple intraductile papilloma of the breast. We all realize that the primary purpose of any breast operation is to establish a diagnosis and to effect a cure. We believe this can be done by the method described.

Of course, simple mastectomy is always the easiest and perhaps the safest treatment for any benign lesion of the breast, but in our opinion it is quite unnecessary. It causes unnecessary psychic trauma to the patient and is needless in so far as curing the disease is concerned.

There are two or three little points about this disease that I think need emphasis. The incision is important and should always be around the periphery of the areola. I believe everybody agrees with that. If you make little cross-hatches on the incision so that the edges can be accurately approximated, when the wound is closed the nipple will stand erect. If the medial margin is not accurately approximated to the peripheral margin, the nipple will invariably lean to one side. This is a very disturbing result to most women.

We in our hospital believe that the question of frozen section of these lesions should be decided by gross examination. If there is something about the gross examination that makes one suspicious that an adjacent carcinoma exists, we do a frozen section; otherwise this soft, friable material is always saved for routine, careful paraffin study, because if you attempt to do frozen sections the diagnosis will not be accurately and properly made in most instances.

I should like to emphasize that we in no way are advocating local excision of cancer of the breast, which I have been accused of on more than one occasion.

I should like to speak very briefly about Dr. Goode's paper. I think we should thank him for bringing this to our meeting for open discussion.

My former chief, Dr. James Allen of Boston, has been doing this procedure for 10 or 15 years, and at his suggestion I began the procedure some 10 years ago.

I am not going to bother you with the figures, but my results of several hundred cases treated by this method have been those of Dr. Goode's. I believe, Dr. Davis, that simple aspiration would have cured the 92% of the cases which you excised. That has been my experience.

It is a very simple, easy, office procedure. We have examined hundreds of slides and have found no evidence of malignancy in these lesions which are grossly ordinary, simple, little or large, blue-domed cysts.

I think the procedure is a good one, and it should be used more frequently by those skilled in surgery of the breast.

Dr. Howard E. Snyder, Winfield, Kan.: I should like to discuss the paper by Drs. Goode, McNeill, and Gordon.

The late Dr. Tom Jones practiced aspiration of breast cysts. In his hands and in those of the authors, surgical removal of residual masses has been promptly accomplished, and mistakes have not occurred. However, if aspiration of breast cysts should become common practice, mistaken diagnoses and delayed treatment of breast carcinoma would certainly result.

If the procedure is to be used, it should be used only by those who are prepared to do any indicated surgery on the breast and only for patients who have agreed to any necessary surgery.

We do not use it for patients with this first solitary nodule, but limit its use to patients who have had a previous biopsy which showed cystic disease with no evidence of hyperplasia or piling-up and papillary projections in the epithelium of the lining cysts and adjacent ducts.

Fluid aspirated is submitted for cytological study, to be completed within 24 hours. If the lump completely disappears, if the fluid is not bloody and contains no suspicious cells, the patient is carefully followed. If the lump recurs, it is removed.

Dr. Dewey Bisgard, Omaha: I wish to discuss Dr. Carroll's paper, which I feel is a very important one.

For quite a number of years I have been doing a routine simple mastectomy at the time of doing a radical mastectomy for carcinoma as a prophylactic procedure because I have had the experience that Dr. Carroll has pointed out in three instances, namely, seeing patients upon whom I had done a radical mastectomy return a year or two or three later with a carcinoma in the previously normal breast.

Furthermore, I think the patient is less deformed by the removal of both breasts than by leaving one, particularly if it is a large breast.

Dr. Walter W. Carroll, Chicago: I wish to thank Dr. Keyes, Dr. Davis, Dr. Hunt, Mr. Levitt, and Dr. Bisgard for their kind remarks. Perhaps I might make just a few remarks in regard to the questions.

First of all, this goes back to incidence figures. Incidence figures will vary, certainly, depending upon the source of the data. If the figures contain a large number of patients who have come in from a community in which cancer awareness is low, we are going to have a large number of bilateral simultaneous lesions that are inoperable. Our figures pertained entirely to those that were operable lesions according to the usual strict criteria. The largest figure, the figure that seemed to be out of line as compared with others reviewed (all of which will be found in our paper in its published form) is that of Brachetto-Brian from the Argentine. They reported 2250 patients of whom the simultaneous cases numbered 4.5%. Obviously, such a number indicates that this series contained many delayed cases, even though the patients were operated on. Variations of this type were noted in other reports.

The latter authors tried to study the estrogen relationships on a statistical basis. They went into the background of these patients as fully as possible, and perhaps they did show that there was a correlation somewhat similar to that in the family referred to by Dr. Keyes when he quoted Dr. Willis' work.

This endocrine relationship seems to be more subtle than just what you can find from statistical relationships. For example, I have in my hand seven references suggesting a causal relationship in the development of spontaneous carcinoma of the breast in males under estrogen therapy, but perhaps that isn't the total exact cause. It rather may be the inciting proximate cause, but before this acts there seems to be much more complex biochemical mechanism going on which may well be an antecedent factor prior to the use of the estrogen.

Dr. John V. Goode, Dallas, Texas: Dr. Davis, I want to thank you and Dr. Chaffin and Dr. Snyder and Mr. Levitt for discussing our paper.

Apropos of Dr. Snyder's remarks, I can't see why good procedure should be abandoned just because somebody may carry it out poorly. If all general practitioners put a needle in a mass and determine whether it is solid or cystic, then send the patients with solid masses to surgeons, many women now receiving no treatment or being treated by hormone injections would receive earlier treatment for small cancers of the breast.

Also, I can't believe that a woman who has been unfortunate enough to have a cyst should be made to suffer further by an operation if she can be cured by a simple procedure.

Traffic Injuries—A Surgical Problem

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Traffic injuries are a surgical problem. The National Safety Council reports that 38,300 deaths and 1,350,000 injuries occurred in motor vehicle accidents in 1953.[1] This is the problem which causes the most apprehension in the medical personnel, both house staff and attending, as well as in the hospital administration. Since the usual traffic accident affects more than one family, occurs in a public place, and is attended by law enforcement officers, it is usually highly publicized and there may be all manner of legal implications. This is understandable to all who have witnessed the arrival of such accident victims. The howling sirens, the flashing lights, the police cruiser, the questioning newsmen and the worried families, all help to magnify the situation, perhaps out of all proportion. It is with these thoughts in mind that a study was made of all the traffic injuries that visited the Mt. Carmel Hospital emergency room in the year 1953. This institution is a 400-bed general hospital in Columbus, Ohio. It is situated near the center of an industrial city, one block off of National Highway Route 40. It is located in the environs of a metropolitan area of some 500,000 people, and it serves both the urban and the surrounding rural sections. This emergency room is staffed at all hours by interns, residents, and nursing personnel. Attending physicians from every specialty are always available. Laboratory and x-ray facilities are provided at all times.

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GENERAL SURVEY

A survey was made of 9050 emergency room visits to Mt. Carmel Hospital in 1953. It was found that 766, or 8.3% of all these emergencies, were severe enough to require hospitalization. The focal point of our examination was the group resulting from traffic accidents. An attempt was made to answer such questions as these: What time of day are the most accidents seen? What season of the year are such emergencies most likely to occur? How severe are these types of injuries? What body areas are most likely to be involved? How often is it necessary to admit these accidents to the hospital for treatment? How best can the emergency room be serviced with all types of medical personnel? Is more emphasis needed in the medical school curriculum on trauma? Should the house staff personnel have more instruction along these lines? Is the immediate attendance of a specialist as necessary as we have been led to believe?

In the beginning, the emergency room visits were subdivided into miscellaneous, medical, industrial, and traffic emergencies. The industrial accidents are self-explanatory, while trauma occurring at home made up most of the miscellaneous visits. Medical emergencies included all diagnostic problems. Miscellaneous, of course, made up the largest group, which amounted to 48%. Industrial emergencies accounted for 23%, while the medical represented 21%. There was a total of 724 traffic injury visits, which accounted for 8% of the total cases brought into the emergency room in 1953.

It is interesting to observe that although the traffic injuries accounted for only a small percentage of all emergency room visits, these injuries would appear to be the most severe. We also discovered that only 1 in 40 of the miscellaneous, 1 in 20 of the industrial,

and one in 8 of the medical emergency room visits were severe enough to be admitted to the hospital, while 27%, or roughly 1 in every 4 traffic victims required hospitalization (Chart 1). There were some 724 traffic injury visits from 472 accidents. Thus, it becomes obvious that an accident does not always involve two victims. We found that 40% of the traffic injuries were from collisions and 28% were noncollision accidents such as those caused by cars being overturned or driven off the road. Pedestrian accidents accounted for 19%, and the remainder, or 13%, included such things as train, bicycle, and motorcycle collisions with automobiles. It was interesting to note that

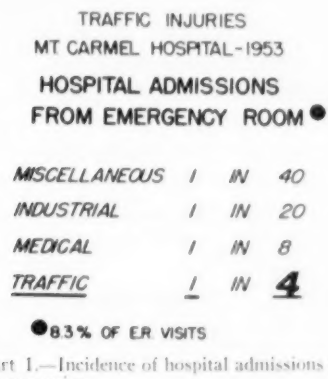

Chart 1.—Incidence of hospital admissions following emergencies.

our hospital admissions were equally distributed between the urban and rural areas.

In answer to the question "What time of day are most accidents seen?" it was found that 17% of the emergency room visits for traffic emergencies occurred between 12 midnight and 6 a. m., while 12% occurred between 6 a. m. and 12 noon. It is readily noted therefore, that only 29% of these emergencies occurred in the morning hours and 71% were seen between 12 noon and 12 midnight. Of these, 31% were seen between 12 noon and 6 p. m. and 40% were seen between 6 p. m. and midnight. The most active single hour was between 4 and 5 p. m.

An analysis of these visits would tend to show that the hours of dusk and darkness are the most dangerous times to travel. Although the same volume of traffic occurs in the early morning hours as occurs later in the day, there are many fewer accidents. This suggests that fatigue is still another factor in frequency of accident occurrence. Therefore, it is during the afternoon and evening hours that the emergency service should be the most efficiently attended by both medical and nursing personnel.

In answer to the question "What season of the year are such emergencies most likely to occur?" it was found that, in 1953, there were definitely certain seasons when there were more accidents. In winter there were the least number of visits from traffic accidents, as only 22% of the total 472 accidents occurred in winter, 25% in the spring, 24% in the summer, and 29% in the fall. The seasonal occurrence of accidents and emergency room visits roughly correspond, since 19% of the visits were in winter, 25% in the spring, 24% in summer, and 31% in the fall. The most obvious reason for the reduction in the winter is the lack of travel. Another factor of interest is that 65% of deaths and 60% of all traffic injuries that were analyzed occurred in persons of 30 years or younger.

THE EMERGENCY ROOM

The most permanent of the emergency room personnel is the nursing staff. The length of time that the hospital intern spends on this emergency service varies. In this period, he is supposed to develop confidence and decisiveness out of all proportion to his training. When he is just becoming secure in his decisions, he is placed on another service. It is the nursing personnel that changes very little day and night, the year around, and sometimes it stays the same for many years. Nurses become quite adept in making good, practical decisions and are a great asset to the intern, resident, and attending medical personnel. It becomes apparent that the emergency room efficiency is proportionate to the amount of time and effort the attending staff takes to instruct the nurses in the care of emergencies. It behooves every hospital which rotates its interns through an

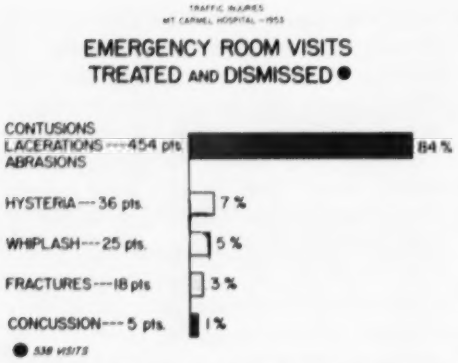

Chart 2.—Diagnoses of traffic injuries treated in emergency room and dismissed.

emergency service to spend time early in the young physician's training in the instruction of how to care for emergencies.

EMERGENCY ROOM VISITS

There were 724 emergency room visits for traffic injuries in Mt. Carmel Hospital in 1953. Approximately 75% of these were treated and dismissed, while some 25%, or one in four, were severe enough to be admitted to the hospital.

There were 538 traffic injuries which were treated and dismissed. A tremendous proportion of these injuries were diagnosed as lacerations, contusions, and abrasions. These diagnoses were made on some 454 patients, or 84% of the total.

Hysteria was diagnosed in 36 patients; whiplash injuries to the neck were present in 25 patients. There were minor fractures in 18 patients, and concussion had occurred in 5 patients (Chart 2).

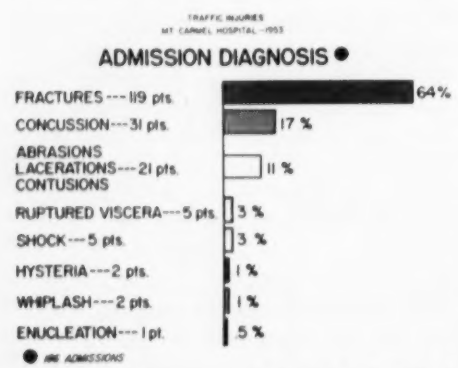

Chart 3.—Diagnoses of traffic injuries admitted to the hospital.

In answer to the question "How severe are these types of injuries?" it is to be noted that a total of 186 of the cases seen in the emergency room were severe enough for hospital admission. An analysis of these admissions shows that 119 patients, or 64%, sustained fractures; 31 patients suffered concussions; 21 patients were treated for abrasions, lacerations, and contusions. Intra-abdominal injury with ruptured viscera was diagnosed in five patients; shock was noted in five patients; hysteria was apparent in two patients; whiplash injury to the neck was noted in two patients, and one patient sustained a severe eye injury that required enucleation (Chart 3).

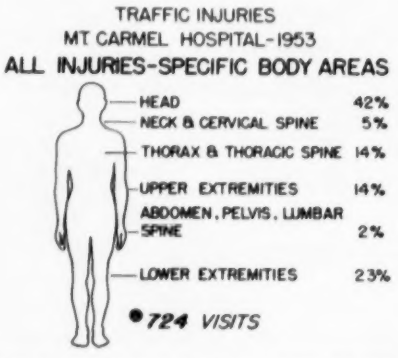

Chart 4.—Distribution of body areas injured by traffic accidents.

One asks, "What body areas are most likely to be involved?" When the entire number of visits are reviewed, the preponderance of injuries are contusion, lacerations, abrasions, and fractures. When the 724 visits were anlyzed as to the specific body area injured, it was found that the head sustained some form of injury in 42% of the 724 visits. The neck and cervical spine was injured in 5%; the upper extremity in 14%; thorax and thoracic spine in 14%; the abdomen, pelvis, and lumbar spine were hurt in 2%, and the lower extremity was involved in 23%. An analysis of all injuries revealed that the head is by far the body area most

frequently injured, followed next by the lower extremity. Injuries to the cervical and abdominal areas were infrequent (Chart 4).

It becomes apparent that the largest majority of traffic accidents treated in the Mt. Carmel emergency room were treated for lacerations, contusions, and abrasions and dismissed. These injuries are usually treated by the youngest member of the hospital medical staff. A study was made of the lacerations; it was found that the head sustained 79% of all that occurred. The upper extremity was involved in 14 patients and the lower extremity in 22 patients. One sees, therefore, that one in every four patients received a laceration, and most of these were on the head.

A further study shows that, of the head lacerations, the scalp was involved in 33 patients; the forehead in 24 patients, and the face in 82 patients, or 47%. Therefore, it would appear essential that the training physician be taught basic wound care, but more emphasis should be placed on attention to the cosmetic result. It is realized that this analysis is from a large hospital in a large city, where plastic surgeons are available; yet practically all such injuries are cared for by the intern. This is also the case in rural hospital areas, where highly specialized plastic surgery is definitely not available. As previously stated, the head was injured in 42% of all emergency room visits for traffic injuries. So, it would appear that highly trained neurosurgical personnel should be in constant attendance for these injuries. However, a further examination shows that of the 305 persons who received head injuries, some 76% were for lacerations, abrasions, and contusions; 12% were for fractures, and 12%, for concussions. It was the intern who treated the greater proportion of these injuries without hospitalization.

A further analysis of the fractures about the head revealed that, of the 37, there were 23 patients who sustained skull fractures and 9 who had fractures of the facial bones alone, while a combination of skull and facial fractures was noted in 5 patients. There were a number of the head fractures that required maxillofacial surgery without neurosurgical attendance. It will be noted later, under deaths from traffic injuries, that the main causes of such deaths were skull injuries.

HOSPITAL ADMISSIONS

Of the hospital admissions, the largest number were due to fractures and amounted to 62% of the 186 total. A thorough study of the fractures was done in an effort to find what specific body area was most apt to be involved. Analysis of 167 fractures showed that 22% involved the head, 3% the cervical spine, 19% the upper extremities, and 21% the thorax and thoracic spine; 10% were in the pelvis and lumbar spine, and the lower extremities were involved in 25%. The head, upper extremities, thorax and thoracic spine, and lower extremities were the ones most generally fractured. Cervical spine, pelvis, and lumbar spine were the areas receiving the least number of fractures. Of the 186 hospital admissions for traffic injuries, 50 patients, or 27%, required shock therapy in the emergency room prior to their admission to the hospital.

It was amazing to find that, out of the total 724 emergency room visits for traffic injuries, only 7% required some surgical procedure in the operating room, and that only 51, or 30%, of the 186 hospital admissions required such care. Thus, we see that only a small percentage of the emergency room visits for such injuries required specialized medical personnel. Of the 51 patients requiring surgery in an operating room, 59%, or 30 patients, were treated for fractures, excluding the head. Of these, 77% were treated by open reduction and 23% by a closed method. If a limited definition for general surgery is used, we find only seven patients who required such service; four of these were for intra-abdominal injuries and three for severe lacerations. Some six patients required maxillofacial surgery for facial bone injuries. There were four patients who required an eye, ear, nose, and throat specialist, while three patients had a neuro-

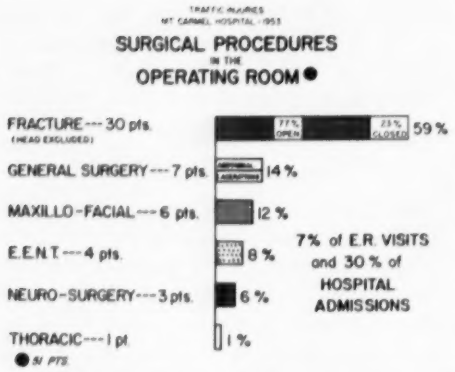

Chart 5.—General classification of surgical procedures performed in operating room.

surgical procedure, and one patient had multiple rib fractures treated by a thoracic surgeon (Chart 5).

A further analysis of the hospital admissions shows that not only are there few admissions that require a surgical procedure in the operating room but that even these can be handled with more deliberation, less fright and confusion. It was also apparent that only 46% required surgery in the first 12 hours, while 24% were operated in the first two hours. The majority, however, which amounted to 28 patients, or 54%, underwent operation some time after the day of admission.

DEATHS

There were 30 deaths from motor vehicle accidents, which were cared for by the personnel of Mt. Carmel Hospital, in the year 1953. Of these deaths, 13 were patients who were pronounced dead on arrival at the emergency room, and 8 died soon after their admission to the emergency room, with only 1 of these patients surviving as long as an hour. These were all coroner's cases, and the data which we were able to collect from the emergency room records and the death certificates showed that these 21 persons suffered severe multiple injuries. Of these persons, 16 sustained severe skull fractures and 3 patients were diagnosed as having spinal cord injuries. In two of the deaths, the principal cause was a severe chest injury. Thus, we see that in 21 patients death occurred so rapidly, from such severe injuries, that no definitive treatment could be instituted. Analysis of the hospital deaths was made to see if improved therapy could have lowered this mortality. There were 9 patients, of the total 186 hospital admissions for traffic injuries, who died in the hospital. Of this number, two had a diagnosis of a cerebral vascular accident, with minimal traumatic wounds. In these cases, it was believed that death was a result of disease rather than the traffic accident. No definitive therapy for trauma was performed in these cases. Two persons sustained severe head injuries, with skull fractures, and a craniotomy was done on them as a last resort. There was one head injury in a patient who had a questionable intra-abdominal injury. This patient died within 16 hours after admission. One elderly patient suffered severe compound fractures of both lower legs, sustained as a result of a pedestrian accident. He was treated for shock and had the wounds debrided and casts applied. All this was done without anesthesia, as he never regained consciousness. Three persons died after laparotomies. The first sustained a rupture jejunum. The second suffered from an injured spleen. The third had a torn ovarian artery with a term pregnancy (Chart 6). Although abdominal injuries were infrequent, they were a major cause of death. Damage to a hollow or solid abdominal viscus must be repaired within a very few hours or a fatality will be the result.

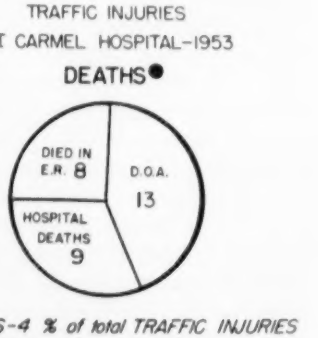

Chart 6.—Deaths from traffic accidents in relation to time of occurrence.

SUMMARY

A survey was made of 9059 emergency room visits to Mt. Carmel Hospital, Columbus, Ohio, in 1953.

Of all the emergencies, 8.3% were severe enough to require hospitalization.

Traffic injuries accounted for 8% of the total emergency room visits.

Of all the traffic victims, 75% were treated and dismissed.

Of all the traffic victims, 25% required hospitalization.

Over 70% of all traffic injuries were treated between 12 noon and 12 midnight, and the hours of dusk and darkness were the most dangerous times to travel.

The fewest injuries occurred in the winter season, and the greatest number happened in the fall.

The majority of the traffic victims were 30 years of age or younger.

The majority of traffic injuries were diagnosed as lacerations, contusions, and abrasions.

The head was the part of the body most frequently injured in traffic accidents. It was involved in 42% of the total cases. Laceration was the commonest type of head injury.

The occurrence of fractures was the commonest cause for hospital admissions.

Of the total emergency room visits for traffic injuries, 7% required a hospital surgical procedure, and only 46% of these were done in the first 12 hours after admission.

The majority of the hospital surgical procedures were for fractures.

CONCLUSIONS

To a great extent, the emergency room efficiency is paralleled by that of the nursing personnel.

Any physician responsible for emergencies must familiarize himself with the principles of resuscitatiton. These include the management of shock and the establishment of an adequate airway, which may require an emergency tracheotomy. He must have a knowledge of head, thoracic, and abdominal injuries, since they account for the largest percentage of fatalities. While adequate treatment to these regions may be life-saving, the greatest need for the doctor's skill is in the treatment of fractures and the débridement and repair of lacerations. Since these lacerations most commonly involve the face, it is important that the physician emphasize the cosmetic care of such wounds.

The problem of trauma deserves the consideration commensurate with its frequency of occurrence. During the internship, the care of trauma should be reemphasized, since most of such injuries are cared for by physicians with this amount of training. It should be taught as an organized subject, considering the patient as a whole.

DISCUSSION

Dr. Michael Mason, Chicago: Dr. Zollinger has opened up a very important field in surgery, that of trauma. Trauma is probably the most frequent cause for surgical disease.

The automobile is one of the big factors in trauma. Any disease condition which kills in the neighborhood of 50,000 people a year and injures in the neighborhood of 1,250,000 people a year is extremely important from the standpoint of the surgeon and from the standpoint of the public as well. Our responsibility as surgeons in the management of automobile injuries, as I see it, is threefold.

Dr. Zollinger has covered the matter of care of the patient after he reaches the hospital. We certainly have a responsibility in the care of the injuries. This begins not just in the emergency room of the hospital, where, oftentimes, the care is not the best in many cases, but care begins with first aid on the road. We have a certain responsibility in teaching people how to administer correct first aid and in what should be done. That protective care started as first aid continues on through the emergency room and on until the patient is healed.

We have another responsibility, and that is in teaching the care of trauma to our students, interns, and residents. It is my feeling (and I am sure many of you share it with me) that we do not emphasize enough in our medical schools the teaching of trauma and the principles of the care of injuries.

We have a third responsibility, and that is the responsibility of recommending measures for the prevention of trauma or at least to ameliorate the injuries that do occur. There are a number of organizations which are taking a great deal of interest in this. In the State of Colorado the State Medical Asssociation is greatly interested in the

matter of automobile injuries, and a few weeks ago at the Clinical Congress of the American College of Surgeons we had a very fine paper by Dr. Horace E. Campbell at the symposium on trauma. He gave us a very fine talk on automobile injuries, how they happen, and what can be done to help prevent them or render them less serious.

The National Safety Council is doing a great deal in the prevention of trauma. The American Society for the Surgery of Trauma and the Committee on Trauma of the American College of Surgeons are doing good work. That is something this Association might think about, the inclusion of more papers on trauma in our programs.

This has been a very fine and most interesting paper.

DR. WALLACE P. RITCHIE, St. Paul: Dr. McMillan, members and guests: Dr. Zollinger's point that accidents are no respecters of the specialties certainly is well taken. I wish to make one point in that connection:

Every year there are a number of individuals throughout the country who die because of extradural hematoma. This is usually due to the fact that neurosurgical consultation is too far removed to get the consultants there in time and the patient cannot be transported to them, or because there is nobody in that community who is qualified or who has ever attempted an emergency trephination.

In view of this we have tried to pick out several men in the State of Minnesota, far removed from the metropolitan areas, who are well qualified, and we have tried to interest them in at least being able to do an emergency trephination for extradural hematoma.

One instance may be of interest to you. There is a small community 60 miles east of St. Paul, in Wisconsin, in which there are three very well-qualified general practitioners. They have a number of cranial cerebral injuries to take care of every year because of accidents on the highways going through their city, and they always ask for consultation quickly or else send their patients in quickly. They always worry about the question, "What if we have an extradural hematoma and we can't get you, or we can't send the patient in? What shall we do?"

After a good deal of thought, and also because I knew they were very competent men, I told them to at least buy the very few fundamental instruments with which they could make a trephine. Six months later they called me. It was obvious that they had an extradural hematoma case on their hands. I was afraid that by the time I reached them the patient would be dead because of the rapidity of the symptoms. Fifteen minutes before I arrived the patient had stopped breathing.

When I got to the operating room, they had made a trephine and had evacuated a large clot, and before I could put on my gloves and gown the patient started breathing again, and recovered. He is now carrying on his occupation as an undertaker. [Laughter]. He was also cured of his alcoholism by that operation. [Laughter].

As the general surgical resident goes out to these smaller communities (as he will some day), he should have some opportunity to become familiar with the emergency trephination and control of the extradural type of hematoma. I am sure most of them don't have that opportunity now, but I think it is most important that they receive that training.

REFERENCE

1. Accident Facts, Chicago, National Safety Council, Inc., 1954.

Adrenal Cortical Hyperplasia and Virilization of the Female

E. STEWART TAYLOR, M.D., Denver

Virilization of the female may occur from adrenal cortex hyperplasia during fetal life or at any period after birth. The syndrome has been recognized in varying degrees of severity, ranging from advanced masculinization of the host to such mild manifestations as oligomenorrhea, infertility, and mild hirsutism.* This paper is limited to a discussion of adrenal cortex hyperplasia as a cause of virilization in the female. In a previous publication we reviewed this and other causes of virilization of the female child and adult.[4] The study of the urinary corticoid excretions has aided the understanding of the syndromes associated with adrenal cortex hyperplasia.† More recently the histochemical demonstration of zonal pathology in the adrenal cortex of patients with adrenal hyperplasia has improved our understanding of etiology and treatment of this disease.‡ Some types of adrenal hyperplasia may be treated surgically, but adrenal virilism from hyperplasia is fundamentally an endocrine disorder amenable to medical treatment except for the surgical procedures that need be performed on the external genital organs of the most severely affected patients.

From the Department of Obstetrics and Gynecology, University of Colorado School of Medicine.

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

* References 1, 2, and 3.

† References 5 to 8.

‡ References 3 and 9.

TYPES OF ADRENAL VIRILISM CAUSED BY ADRENAL CORTEX HYPERPLASIA

1. *Congenital Adrenal Cortex Hyperplasia (Female Pseudohermaphrodite).*—Such a patient is born with confusing external genital anatomy. The doctor is usually unable to state with certainty the sex of the child at birth; the phallus is grossly elongated, and there is a urogenital sinus opening into the perineum through which micturition occurs (Fig. 1). The internal female genital organs are present and normal except for their small size. Somatic growth is rapid and precocious, as is the appearance of pubic and axillary hair. Menstruation does not occur, and at age 12 to 15 excessive facial hair and excessive body hair appear. The urinary excretion of 17-ketosteroids is elevated considerably above normal. We have seen a number of such patients between the ages of birth and 31 years. The most famous and the earliest such person reported is Joseph (ine) Marzo, who died in 1866.[10] This person lived a lifetime as a male but was a female with congenital adrenal hyperplasia. The autopsy described the adrenal glands to be as large as kidneys.

There is a subgroup of congenital adrenal cortex hyperplasia known as the salt-losing type.§ Such a patient exhibits the findings of female pseudohermaphroditism but may develop adrenal cortex failure as a complication of infection, dehydration, or other trauma. Figure 2 shows one such patient that was first seen in our clinic because of unexplained peripheral vascular collapse. Investigation of the patient confirmed the diag-

§ References 11, 12, and 13.

Fig. 1.—External genitalia of a 7-year-old female with congenital adrenal cortex hyperplasia. Urinary meatus is directly below the hypertrophied phallus. The vagina is recessed behind the sinus. (Reproduced from Taylor, E. S., and Snow, R. H., in the *American Journal of Obstetrics and Gynecology*, St. Louis, The C. V. Mosby Company, 1954, Vol. 67, p. 1307; Figure 2.)

nosis of adrenal cortex hyperplasia, congenital type, with the added disability relating to sodium chloride metabolism. Keeler and coworkers have recently reported three such patients.[14] The 17-ketosteroids are elevated, while the sodium and chlorides of the serum are low.

2. Acquired Adrenal Cortex Hyperplasia.—This is a most interesting condition in that it may appear in mild to severe forms of virilization. Patients with acquired adrenal cortex hyperplasia may be divided in three groups according to severity of symptoms and signs.

These groups are the following:

(*a*) Postnatal Virilization: This is a relatively uncommon group, whose members develop hirsutism, enlargement of the clitoris, and markedly elevated 17-ketosteroids after birth. Later there is amenorrhea and either failure of development of secondary sex characteristics or surpression of them if they have already appeared. These patients differ from the congenital group in that the manifestations appear after birth and therefore anomalies of the urogenital tract are not present except for hypertrophy of the clitoris and hypoplasia of the uterus, tubes, and ovaries. I have seen a number of patients in this category. Cortisone will cause the 17-ketosteroid levels in the urine to become normal, and menstruation may be expected. I had one such patient who was treated with cortisone whose 17-ketosteroids fell to normal, breast development occurred, and the hirsutism improved mildly. Menstruation did not start after six months of treatment, at which time the patient moved to another state and I lost her for follow-up.

Fig. 2.—External genitalia of a 5-month-old girl with congenital adrenal cortex hyperplasia (salt-losing type). This patient entered the hospital because of an Addisonian crisis.

(*b*) Postpuberty Hirsutism with Elevated 17-Ketosteroids: This syndrome is characterized by amenorrhea or oligomenorrhea and some degree of hirsutism and infertility. The urinary 17-ketosteroids are elevated to 25 or 30 mg. per 24 hours. The menarche may occur at the usual time or may be delayed. The secondary sex characteristics are usually normally developed. The pubic hair is often of male distribution, and some breast development is present. The patient often complains of excessive hair on the face and the extremities. The patients may have anovulatory menstrual cycles and consult their doctors because of hirsutism, infertility, and oligomenorrhea. Cortisone has been reported as being successful in that menstruation has become normal; pregnancy has followed, and there has been improvement in the hirsutism.‖ I have had four such patients. In three, regular menstruation has occurred, but there have been no pregnancies.

(*c*) Postpuberty Hirsutism with Normal 17-Ketosteroids: This group is essentially the same as Group *b* except that the urinary 17-ketosteroids are normal, but, as pointed out by Jones,[3] the clinical response to cortisone treatment is the same as may be expected in the group with elevated 17-ketosteroids. Jones reports the establishment of normal menstruation and subsequent pregnancy in some after cortisone treatment.[3]

‖ References 1, 2, and 3.

HISTOCHEMICAL STUDIES OF ADRENAL PATHOLOGY

Blackman[9] and Jones[3] have reported some interesting work concerning the location of the abnormal pathology in the adrenal cortex associated with adrenal cortex hyperplasia. By a study of autopsy material and surgical specimens after histochemical staining, they have demonstrated that the reticularis zone of the adrenal cortex is grossly hyperplastic in cases of adrenal cortex hyperplasia causing virilism. They believe that the reticularis zone is the site of production of the abnormal androgens which virilize the host.

Both authors have found that in the subgroup (salt-losing type) of patients with congenital adrenal cortex hyperplasia who are subject to adrenal cortical shock and collapse there is hyperplasia of the reticularis zone with an accompanying atrophy of the glomerulosa zone. It is thought that the glomerulosa layer is the zone concerned with salt, chloride, potassium, and water metabolism. Addisonian crisis may be a complication.

All their studies showed absence of lipid in the fasciculata layer of the adrenal cortices from virilized patients with adrenal cortex hyperplasia. This corresponded with the extremely thin anatomical appearance of this layer at autopsy. The primary pathology in patients with hyperplasia causing virilization is thought to be inadequate cortisone production from the fasciculata zone. The result is that corticotropin (ACTH) stimulates the reticularis zone to hyperactivity and hyperplasia, since corticotropin is unopposed by cortisone. If cortisone is given, the symptoms caused by hyperplasia can be relieved.

The information concerning the abnormal functional areas of the adrenal cortex is of clinical interest. The knowledge that certain newborn infants diagnosed as having female pseudohermaphroditism (congenital adrenal cortex hyperplasia) may exhibit Addisonian crisis from trauma such as surgery or infection will cause anyone undertaking surgery on such a patient to fortify the hypofunction of the glomerular zone while surgically correcting the congenital abnormalities of the genital organs.

I have seen several cases of congenital hyperplasia that have caused virilism and marked abnormalities of the external genital organs. For differential diagnosis it is important that the 17-ketosteroids be studied and that tumors of the adrenal gland or ovary be excluded. Cortisone may be used to depress the amount of corticotropin coming from the pituitary gland and thereby bring about a medical reversal of the virilism to femininism. It is important that the diagnosis of adrenal cortex hyperplasia and virilism be established in the young patient, in order that precocious somatic growth and early closure of the epiphyses be prevented. The condition needs also to be treated so that puberty will occur normally. Cortisone will substitute for inadequate production of that steroid by the fasciculata zone of the adrenal cortex; corticotropin will be opposed; excess androgen production will halt, and normal menstruation will occur. I have seen this happen in a patient who was 31 years old before the diagnosis of congenital adrenal cortex hyperplasia was made, and she had never had a menstrual period until she had been placed on cortisone treatment.[4]

SURGICAL ASPECTS OF ADRENAL CORTEX HYPERPLASIA

The surgical treatment of various forms of adrenal cortex hyperplasia causing virilism of the host is limited to the correction of the abnormalities of the urogenital tract. Usually the correction of the abnormalities is quite simple. The phallus should be amputated. The urogenital sinus below the phallus should be opened, and by this procedure the hidden vagina can be brought to full view (Fig. 3). The atrophic cervix will appear at the apex of the vagina. The uterus, tubes, and ovaries can be found in their normal positions if a laparotomy is done. It is usually not necessary to do a laparotomy to confirm the diagnosis if the 17-ketosteroids are elevated and if the 17-

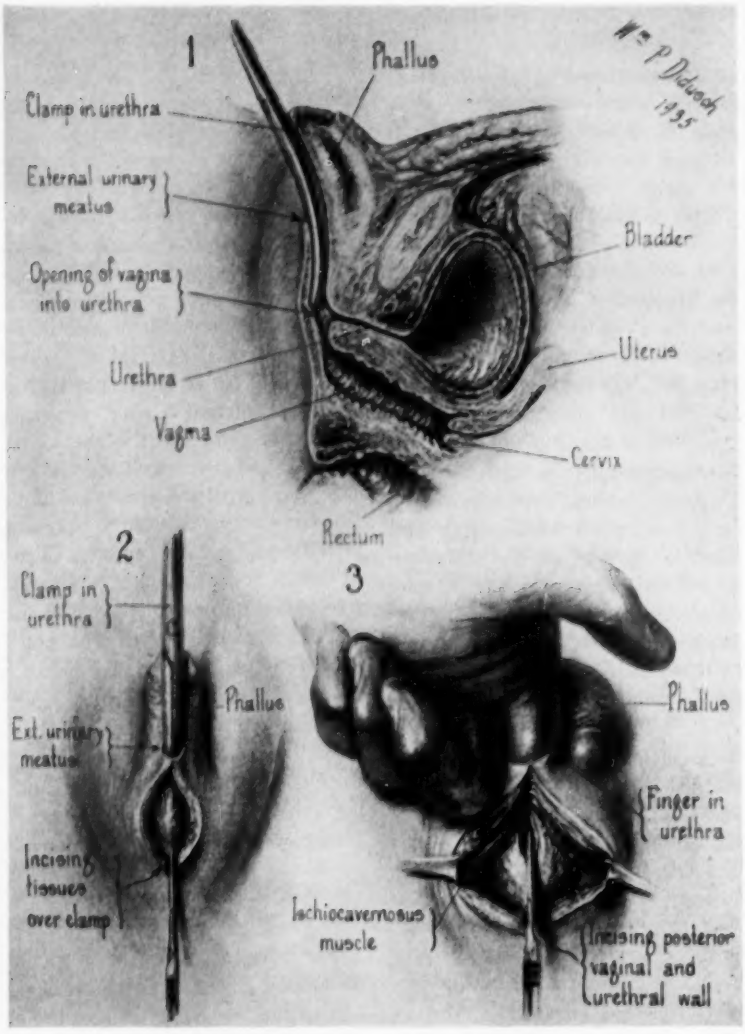

Fig. 3.—Anatomical factors present in the usual female patient with congenital adrenal cortex hyperplasia and the principles of surgical exposure of the recessed vagina. The hypertrophied clitoris should be amputated. (Reproduced from Young, H. H.: Genital Abnormalities. "Hermaphroditism and Related Adrenal Diseases." Baltimore, Williams & Wilkins Company, 1937.)

ketosteroids can be brought to normal with cortisone therapy. It is felt that it is better to wait until puberty to do the plastic revision of the vaginal opening. It is interesting to note that adrenal cortex hyperplasia causing virilism of the female is treated with cortisone and that reversal of the virilism and fall of the 17-ketosteroids to normal can be expected. On the other hand, the adrenal cortex hyperplasia which produces Cushing's syndrome may often be treated surgically by adrenalectomy, complete or partial. One might infer that the fasciculata zone is the area of hyperfunction and hyperplasia in Cuching's syndrome, since it is from this zone that glucocorticoids are believed to arise. It has also been noted that when hirsutism is a part of Cushing's

syndrome the reticularis is thickened. Surgical excision of the adrenal glands has not been helpful in the treatment of adrenal cortex hyperplasia causing virilization primarily. Wilkins[18] has demonstrated that the elevated 17-ketosteroids can be made to fall to normal by the administration of cortisone if the patient has hyperplasia causing virilism. If, on the other hand, the 17-ketosteroid level remains elevated while the patient is receiving cortisone for 7 to 10 days, the diagnosis is likely to be a tumor of the adrenal cortex.

SUMMARY

The pathologic physiology of adrenal cortex hyperplasia associated with virilization of the host is reviewed. The use of cortisone as an agent for the treatment of adrenal cortex hyperplasia of the virilizing type is recommended. The surgical aspects of the condition and the problems of differential diagnosis are discussed.

CONCLUSIONS

Adrenal cortex hyperplasia of the virilizing type may occur in varying degrees of severity and lead to conditions such as congenital adrenal cortex hyperplasia (female pseudohermaphroditism), acquired virilization, anovulatory bleeding, oligomenorrhea, amenorrhea, sterility, and mild hirsutism, depending on in what period of life it appears and on the amount of adrenal cortex pathology.

A careful study of patients who demonstrate these symptoms may lead to a diagnosis of adrenal cortex hyperplasia, which can often be treated with cortisone.

The surgical treatment of adrenal cortex hyperplasia causing virilization does not include the adrenal gland itself but should be limited to the correction of the abnormal developments that occur in the genitourinary tract of the female.

DISCUSSION

DR. WALTMAN WALTERS, Rochester, Minn.: In the opening paragraph Dr. Taylor's paper presents a classification of types and conditions associated with hyperplasia of the adrenal cortex. Dr. Hayles, one of our pediatricians who is particularly interested in metabolic disturbances, and I have studied the paper with much interest and profit, and we are in agreement with this classification, although we should like to call attention to the fact that not all observers agree that the hirsutism alone is a direct result of adrenal hyperplasia.

In his discussion of the subgroup of congenital adrenal cortex hyperplasias known as the salt-losing type, the author comments that the loss of salt and water may accompany infection, dehydration, and other trauma. We think too that it should be added that in many of these patients it will develop in the absence of any known cause.

The purpose of this paper appears to be to impress on the general surgeon that no operation on the adrenals is indicated in female children who have the adrenogenital syndrome, providing one can eliminate the possibility of a hyperfunctioning adrenal cortex adenoma. The only operation that appears to be indicated for these patients is the correction of the congenital abnormality of the external genitalia.

We agree with the author that the clitoris should be amputated if it is prominent or produces any psychologic difficulty, and I also agree with him and think it is wise to wait until the patient is near adolescence before correction of the vaginal outlet is attempted.

The author's comments referable to the differential diagnosis of adrenal hyperplasia and adrenal tumor have been in keeping with our experience with these conditions, namely, that cortisone usually reduces the excretion of 17-ketosteroids in patients with hyperplasia of the adrenal cortex but not in patients with tumor.

We (Hayles and I) agree with the author that surgical procedures would not be indicated in children for the correction of the adrenogenital syndrome or macrogenitosoma praecox which is due to adrenal hyperplasia, because these conditions can be readily controlled by carefully regulated amounts of cortisone given intramuscularly or orally.

The author has discussed the various types of masculinizing effects that accompany adrenal cortex hyperplasia. It should be remembered that tumors of the adrenal cortex may be associated either with masculinizing or feminizing effects and also may produce hypertension, as has been described, or the tumor may produce no endocrine disturbance whatsoever. In such cases it is very difficult indeed to make the diagnosis.

Differentiation between adrenal cortex tumor and adrenal cortex hyperplasia does not need to be made except when masculinizing effects are present.

REFERENCES

1. Greenblatt, R. B.: Cortisone in the Treatment of the Hirsute Woman, Am. J. Obst. & Gynec. **66**: 700, 1953.

2. Jones, G. E. S.; Howard, J. E., and Langford, H.: The Use of Cortisone in Follicular Phase Disturbances, Fertil. & Steril. **4**:49, 1953.

3. Jones, H. W., and Jones, G. E. S.: The Gynecological Aspects of Adrenal Hyperplasia and Allied Disorders, Am. J. Obst. & Gynec. **68**:1330, 1954.

4. Taylor, E. S., and Snow, R. H.: Adrenal Virilism in Female Child and Adult, Am. J. Obst. & Gynec. **67**:1307, 1954.

5. Simpson, S. L.; de Fremery, P., and Macbeth, A.: The Presence of an Excess of 'Male' (Comb-Growth and Prostate-Stimulating) Hormone in Virilism and Pseudo-Hermaphroditism, Endocrinology **20**:363, 1936.

6. Kenyon, A. T.; Gallagher, T. F.; Peterson, D. H.; Dorfman, R. I., and Koch, F. C.: Urinary Excretion of Androgenic and Estrogenic Substances in Certain Endocrine States: Studies in Hypogonadism, Gynecomastia and Virilism, J. Clin. Invest. **16**:705, 1937.

7. Callow, R. K.: The Significance of Excretion of Sex Hormone in Urine, Proc. Roy. Soc. Med. **31**:841, 1938.

8. Talbot, N. B.; Butler, A. M., and MacLachlan, E. A.: Alpha and Beta Neutral Ketosteroids (Androgens): Preliminary Observations on their Normal Urinary Excretion and Clinical Usefulness of their Assay in Differential Diagnosis, New England J. Med. **223**:369, 1940.

9. Blackman, S. S.: Concerning the Function and Origin of the Reticular Zone of the Adrenal Cortex, Bull. Johns Hopkins Hosp. **78**:180, 1946.

10. Crecchio, L.: Virilism, Ann. hyg., Paris (second series) **25**:178, 1866.

11. Jailer, J. W.: Virilism, Bull. New York Acad. Med. **29**:377, 1953.

12. Wilkins, L.: The Diagnosis and Treatment of Endocrine Disorders in Childhood and Adolescence, Springfield, Ill., Charles C Thomas, Publisher, 1950, p. 221.

13. Wilkins, L.: The Diagnosis of the Adrenogenital Syndrome and Its Treatment with Cortisone, J. Pediat. **41**:860, 1952.

14. Keeler, J. E.; Gainey, H. L., and Nicolay, K. S.: Adrenogenital Virilism with Adrenal Cortical Hypofunction—A Clinical Entity, Am. J. Obst. & Gynec., to be published.

A Method for Determining the Patency of Portacaval and Splenorenal Shunts

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and
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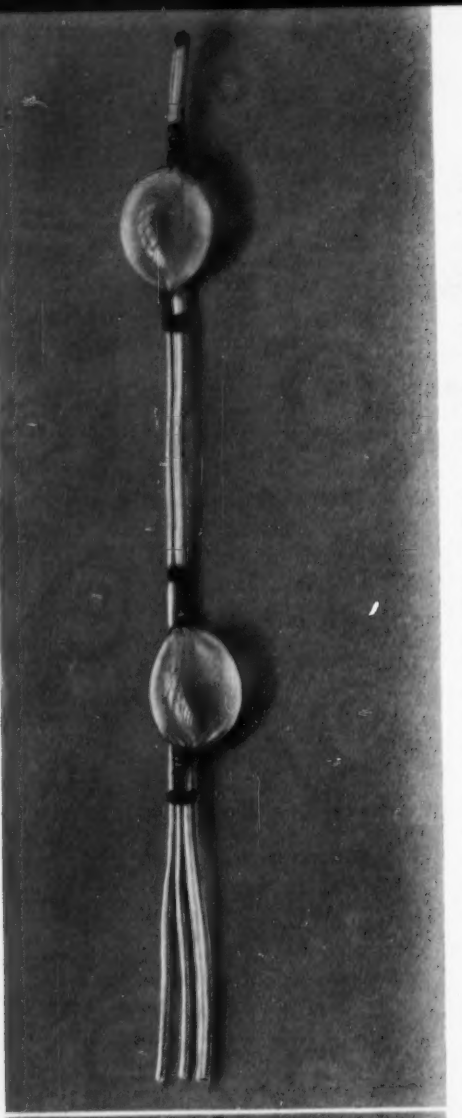
Since 1945, when Blakemore initiated the treatment of portal hypertension by decompressive vascular shunts between the portal and systemic venous systems, the efficacy of this form of therapy has received positive support from multiple sources.* Despite this favorable experience, there has been some reluctance in widespread acceptance of the procedure. In part, this may be due to the magnitude of the operation, the technical difficulties entailed, and the inherent risks. Of equal importance has been the inability to assess accurately the value of such shunts. At present, there is no exact method of determining postoperatively whether the shunt is patent or thrombosed, so that clinical evaluation of operative series must be made without this essential information.

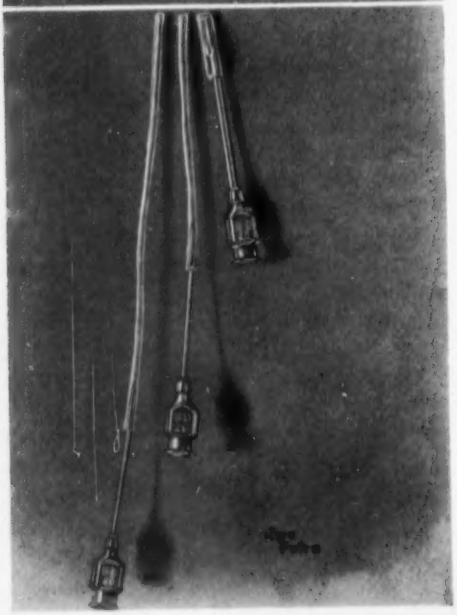
The importance of a simple method to establish definitely the status of the anastomosis has been recognized for some time and has been the subject of considerable investigation. Heretofore, the problem has been approached in several ways. In 1948, Allard[7] passed an intravascular catheter through the external jugular vein inferiorly into the inferior vena cava to the junction of the left renal vein. Dextrose was then given via stomach tube, and simultaneous blood samples were obtained thereafter from the inferior vena cava and a peripheral vein. The presence of a higher blood sugar in caval blood as compared to the peripheral blood affirms the patency of the shunt. Fitzpatrick and coworkers[8] have endeavored to solve this same problem by placing a small polyethylene tube into a vascular radical of the portal vein at the time of surgery. The tube is led out through the abdominal wound and left in place for three to eight days. In the immediate postoperative period, the catheter is utilized for regional heparinization, and by inserting another polyethylene catheter through the femoral vein up into the inferior vena cava, samples of caval blood can be compared with peripheral venous blood as regards clotting time. A longer clotting time for the caval blood indicates patency of the shunt. Giges and Teschan[9] recently suggested the use of the portal circulation time of Newman and Cohen[10] as an index for verifying the presence of venous shunts. By this method the time interval for rectally instilled ether to reach the lung is compared preoperatively and postoperatively. A decrease in portal circulation is evidence of an open anastomosis. De Almeida[11] modified this method by introducing the ether into the small bowel. The last two methods are simple and promising but have certain regions of potential error: (*a*) One must assume that intestinal absorption is rapid and relatively unchanged in different subjects. (*b*) It must be assumed also that the rate of flow through the portal system is inversely proportional to the portal pressure. (*c*) The major objection is that the test is purely subjective and depends upon the patient's appreciation for the end-point.

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

From the Department of Surgery, University of Cincinnati, College of Medicine, and the Daniel Drake Memorial Hospital.

* References 2 to 6.





The most satisfactory method of confirming the adequacy of a portacaval shunt was demonstrated by Dotter, Payne, and O'Sullivan,[12] in one patient. They catheterized the anastomosis via the inferior vena cava and injected the portal system directly with radiopaque dye. Farinas,[13] in his original descriptions of abdominal venography, reported a case in which a portacaval shunt was demonstrated by venography performed directly through the femoral vein. Cooper and others[14] have demonstrated the existence of portacaval shunts by splenoportography. In such instances, injection of the dye is performed percutaneously through the spleen and the portal system and ultimately the vena cava is visualized in this manner if the shunt is patent. These methods of direct visualization have not been utilized extensively, seemingly for various reasons. The method of Dotter demands direct catheterization of the anastomosis, which obviously could prove tedious and difficult for routine use. The method of Farinas, although simple, will not guarantee retrograde filling through the anastomosis to render it a competent method for determining union between the portal and vena caval systems. The method of Cooper was used successfully in patients without any complications. Nevertheless, it requires the presence of the spleen and its percutaneous puncture, a procedure not without risk. Above all, none of the methods previously described have any potential use in the instance of a splenorenal anastomosis.

It seems apparent that the method of direct visualization represents the most desirable method of determining the patency of venous shunts in the postoperative period, if it can be simplified, rendered accurate and safe. As such, it would provide an essential means of assessing the technical success or failure of the operative procedure. Furthermore, in the circumstances where the operative subject bleeds in a period, months or years, after the anastomotic procedure, the informa-

Fig. 1.—Improvised catheter. Balloons are inflated with iodopyracet after proper positioning. Injection is made through perforations in the space between balloons.

tion derived might be more than academic in determining the subsequent methods of treatment. The method to be described has been used thus far only in the experimental laboratory.

METHOD

Fifteen mongrel dogs were prepared by operative production of portacaval and splenorenal shunts. At the time of surgery, the site of the anastomosis was marked with one or two silver clips to indicate its location. In the immediate postoperative period from two days to one week, direct visualization of the site of the anastomosis was secured. The time selected for radiologic visualization was arbitrary. We were interested primarily in establishing the technique and determining its accuracy in visualizing the anatomical character of the venous system. A catheter was improvised consisting of a three-lumen polyethylene tube. Two lumens connect to two inflatable balloons situated 2 in. apart, and the third lumen is used for the injection and is perforated over the interval between the balloons. The catheters were handmade with polyethylene tubing, using latex rubber obtained from finger cots to serve as the inflatable balloons. In the dog, the catheter is inserted into the femoral vein, usually on the right side. In the patient, we anticipate the use of the saphenous vein near the saphenofemoral junction. The catheter is passed up the inferior vena cava and, with the aid of the silver clips, is positioned fluoroscopically so that the proximal or superior balloon is above, and the inferior balloon below, the level of the anastomosis. The injection of 1 to 2 cc. of iodopyracet (Diodrast) into the superior balloon demonstrates its position and simplifies accurate positioning in relation to the clips. The catheter has been inserted in the reverse direction, namely, through the jugular vein and down through the superior vena cava. This has not been so satisfactory, however, since the catheter frequently encounters obstruction in the right auricle or at the level of the hepatic veins and requires repeated manipulation to bypass these points. When proper location has been attained, both balloons are inflated with iodopyracet solution until the desired portion of the vena cava is "trapped." The iodopyracet solution likewise aids in determining the diameter of the balloon and establishing the time when occlusion of the vena cava has been approximated. Between 20 to 35 cc. of 35% iodopyracet is now rapidly injected into the inferior vena cava and a roentgenogram secured immediately at the termination of the injection. When the anastomosis is open, the dye spills over from the inferior vena cava through the anastomosis and outlines the tributaries of the portal system. In the instance where a splenorenal anastomosis is to be visualized, the clips give the approximate level of the junction of the renal vein. The balloons are positioned in similar relationship to the clips, and the retrograde injection diffuses from the vena cava into the renal veins and on the left side outlines the anastomosis with the splenic vein.

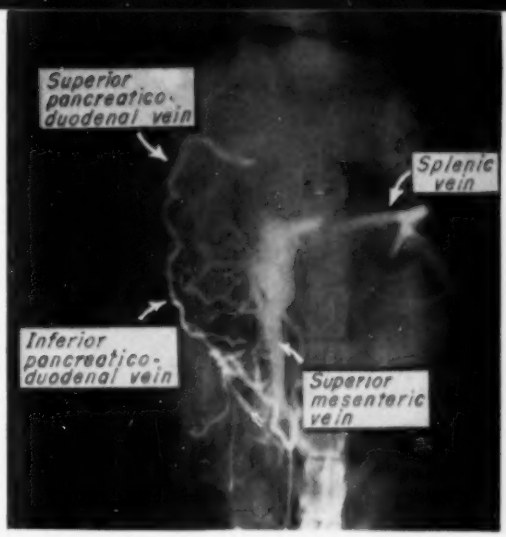
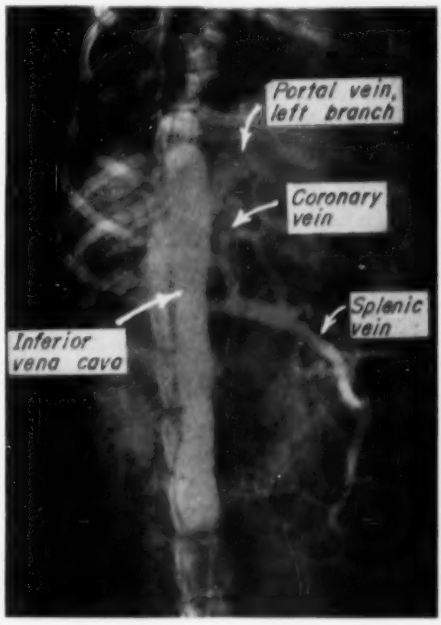


Fig. 2.—Injection of an end-to-side portacaval anastomosis. The anastomosis is patent, and dye spills retrograde from the inferior vena cava into the portal system and tributaries. Note how the dye gets into the hepatic stump of the portal vein via superior pancreaticoduodenal venous pathways.

Fig. 3.—Injection of a patent end-to-side anastomosis with dye outlining tributaries of the portal vein. Again dye enters the hepatic stump of the portal vein through venules in the gastrohepatic ligament.



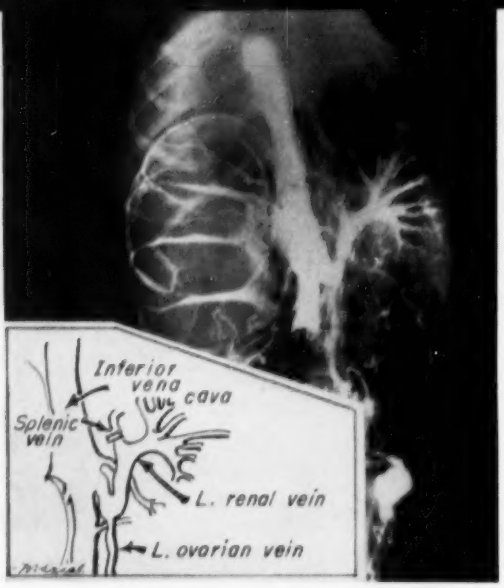


Fig. 4.—Injection of a patent end-to-side splenorenal anastomosis. Note the delineation of the normal architecture of the left renal vein and kidney and the anomaly of the right kidney.

RESULTS

Of the 15 dogs operatively prepared by shunt procedures, there were eight anastomoses of the end of the portal vein to the side of the vena cava and three side-to-side anastomoses. The remaining four dogs had splenorenal anastomoses two of which were end of the splenic vein to the side of the renal vein and two, end-to-end anastomoses. The postoperative visualization of the portacaval shunts has been carried out without particular difficulty in technique or interpretation. Radicals of the splenic or mesenteric systems have been filled, verifying the presence of an open anastomosis. The splenic vein seems more readily visualized than the superior mesenteric trunk, presumably for two reasons: (1) It comes away from the anastomosis at right angles and thus appears to accept the highest concentration of the dye. (2) The superior mesenteric vein is often obscured by the dye-filled shadow of the vena cava. Some confusion arose in one instance where a side-to-side portacaval anastomosis had been performed and where there was inability to fill the vessels with concentrations of dye adequate to visualize the vascular anatomy. In this situation, however, the liver was opacified, and what presumably occurred in this instance was a rapid mixing and diffusion of dye from the area of injection. Only when the dye was retarded in the liver circulation and concentrated could it be visualized. In the case of side-to-side anastomoses then, the injection of the bolus of dye must be done much more rapidly because of the superior mixing. The liver opacification, however, indicating communication with the portal system is evidence of a patent shunt.

In the group of splenorenal anastomoses, it has been possible to demonstrate a patent shunt on only one occasion because of the technical difficulties in affecting a functional union in the dog where the splenic vein is so small. The presence of an occlusion of the anastomosis has been substantiated radiologically in three instances where such circumstance existed and, in so far as the test of the method is concerned, seems equally important. Such injections have visualized the ovarian vessels in the instance of the female so that in the human subject where it is relatively easy to obtain a functional union, we see no particular reason why visualization should not proceed in the expected fashion.

In the animals where end-to-side anastomoses of the portacaval variety were performed, the total division of the portal vein was performed well above the union of the superior mesenteric and splenic veins. Nevertheless, we have been surprised to find that on retrograde injection of the shunt through the inferior vena cava, collaterals have been visualized through the mesenteric system which ultimately unite with the divided hepatic stump of the portal venous system within the liver. This has occurred through two principle routes: (1) When the portal vein is divided in the dog, blood may find its way from the mesenteric venous system through the inferior pancreaticoduodenal vein, anastomosing to the superior pancreaticoduodenal vein which runs beneath the duodenum and anastomosis to small venous channels which run collaterally with the hepatic artery into the portal circulation of the liver. (2) Another route appears to be via the coronary veins through anastomoses along the gastro-

hepatic ligament into the hilus of the liver, so that in the case of the dog, at any rate, total division of the portal vein does not necessarily mean that the liver is deprived completely of its portal circulation. Whether such anastomotic channels exist in the human is a problem for investigation, and what this means in the interpretation of previous liver function studies in the dog as related to end-to-side portacaval anastomoses is a matter of speculation.

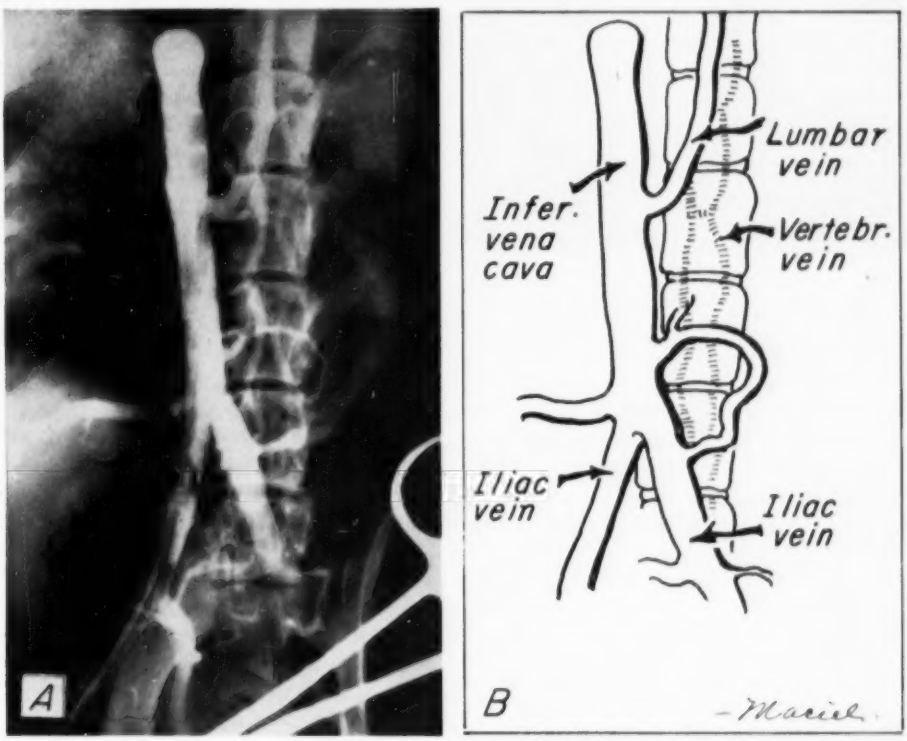


Fig. 5.—Injection of the vertebral venous system through the lower portion of the vena cava. Only the superior balloon is inflated.

In the literature, we discovered that Tori,[15] in 1953, described a similar method of venography for hepatic vein visualization. In such instances, he inserted a tube with a single balloon which was used to occlude the inferior vena cava above the level of the diaphragm, and a retrograde injection was then utilized to fill the hepatic veins. We have experimented with this type of visualization, and, while it is ordinarily adequate to demonstrate a portacaval anastomosis, it does not direct the retrograde filling into the portal system as well as when the selected segment of the vena cava is trapped. In the case of the splenorenal anastomosis, "trapping" appears to be the only satisfactory method of filling the renal venous system, for if the inferior balloon is omitted, the diffusion of dye is principally along the vena cava and iliac vessels.

Certain investigations have been carried out to determine the safety of the method. What effect does venous occlusion have upon the cardiovascular dynamics of the dog under such conditions? In one dog, the venous pressure, carotid arterial pressure, and EKG was taken prior to and during a 30-minute period of inflation of both balloons in the inferior vena cava. During this interval, there

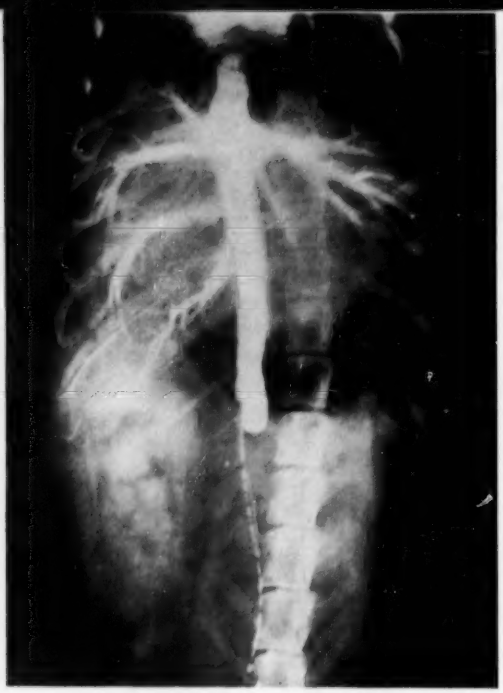


Fig. 6.—Hepatogram via hepatic veins. The superior balloon is positioned slightly above the level of the diaphragm. The lower balloon is inflated and the injection made thereafter. Venous branches to all lobes are visualized.

was a slight fall in the blood pressure from 140 mm. of mercury to 130 mm., and the venous pressure fell slightly from a preinflation level of 3.5 cm. of water to 1 cm. of water. No obvious change occurred in the electrocardiogram. The values rapidly returned to previous levels when the inflation was discontinued. In none of the dogs now numbering 30 in which this type of occlusive venography has been utilized have we ever observed any deleterious effect—even when the proximal balloon has extended above the level of the diaphragm and when they have been inflated for a period as long as 45 minutes. These findings are in accord with the results of Moretz and co-workers,[16] who investigated the physiologic changes which occur from occlusion of the inferior vena cava in dogs and noted no significant change in this time interval.

We were next interested in determining whether or not the injection of radiopaque dye in a retrograde fashion under pressure might cause any damaging effect upon kidney function. Such changes have been noted in cases of translumbar aortography by Miller, Wylie and Hinman.[17] To pursue this point, three dogs in whom the vena caval injection was centered at the level of the renal veins were followed by serial blood urea nitrogen determinations before and after venography. No alterations of the blood urea nitrogen from the normal were observed in the period of one week after injection. In a similar study to determine the effects, if any, which might occur if the injection was made at the level of the hepatic veins, sulfobromophthalein (Bromsulphalein) determination was followed both pre- and post-injection for one week. In two dogs there was an alteration within 24 hours of the BSP from a normal level to a level of 12% and 16%, respectively. This determination returned to limits at or below 5% in the next 24 hours. In the case of the third dog, there was no alteration whatsoever. This would indicate that some slight impairment of hepatic function might occur in such circumstance, but that it is transitory.

There has been one point of concern where one might anticipate real difficulty. It is entirely possible that inflation of the balloons to abnormal pressures might cause a rupture of the inferior vena cava. We have experimented with this situation, both in the living animal and in the cadaver. This complication can be avoided in the following ways: The catheter utilized in the dog has been provided with balloons with an over-all length of approximately 1 in. The injection of 4 to 6 cc. of solution readily occludes the vena cava, depending upon the level of occlusion, since the diameter of the vena cava increases cephalad. There is a latitude of error in the neighborhood of 100%, since an injection of about 10 to 12 cc. of fluid is necessary before rupture of the vena cava will occur in the dog. In the cadaver, 6 to 9 cc. was adequate to occlude the vena cava, depending upon the particular level of the balloon, and an injection in the neighborhood of 20 cc. was required to cause rupture.

1. It is essential that the balloon be of very fine latex material, easily distensible, with low resistance to inflation. Under these conditions, the increased resistance which occurs when total occlusion is being

reached is easily transmitted to the injecting syringe and recognized.

2. Since the distention of the balloon can be followed fluoroscopically, the operator has the opportunity of comparing the diameter of the balloon with the diameter of the vena cava, as noted at the time of operation.

3. No great effort is made to distend the vena cava tightly. Absolute occlusion is unnecessary; relative occlusion is desired, so that the dye will spread along the avenues of least resistance when the occlusion is nearly complete. When the balloon is of easily distensible material and one follows the distention of the balloon under the fluoroscope, it is possible to tell exactly when occlusion has been reached, because the balloon will start to elongate along the axis of the vessel when the lateral resistance of the vessel is encountered.

Danger can arise if the balloon is of more resistant material. It will then tend to keep its spherical shape, and overexpansion of this type of balloon concentrates the expansion over a relatively small surface area. We purposely experimented with this quality in the instance of two dogs in order to obtain the venogram which would occur under such circumstances. In the first instance the dog was immediately autopsied to verify the anatomical findings, and a longitudinal tear was found in the inferior vena cava. In the second animal, the catheter was withdrawn. The dog made an uneventful recovery and three weeks later was subjected to follow-up venography, at which time no abnormal changes could be recognized. Autopsy at this time verified the presence of blood undergoing resolution in the right lumbar area.

COMMENT

In the course of the present investigation, it became recognized that the method has possibilities along other diagnostic lines. Obviously, any portion of the vena cava can be "trapped" and injected in a retrograde fashion. For this reason, it is possible that the method may be of value in the retrograde injection of pelvic veins for the delineation of pelvic tumors and other abnormalities. In the injection of the lower portion of the vena cava, it was soon noticed that this portion of the inferior vena cava had extensive collateral connections through the lumbar veins into the vertebral system of the spinal canal. These venous pathways can easily be demonstrated when the injection is performed at this level. This corroborates the work of Batson [18] who demonstrated these pathways anatomically in man and in monkeys and offered them as the logical explanation of the routes of certain tumors which metastasize to the spine without prior passage through the pulmonary circuit. The ease with which venography of the vertebral circulation can be obtained by this method would suggest its possible diagnostic importance to the neurosurgeon for the diagnosis of spinal cord vascular anomalies, tumor, and block. It has also been demonstrated that the renal circulation can likewise be studied on the venous side by this method. Whether this has any practical application in urologic surgery has to be explored. Certainly the possibility of determining renal vein invasion by hypernephroma immediately suggests itself. With "trap" venography visualization of the hepatic veins of the liver has been obtained with great ease in the experimental animal. We have become particularly interested in this latter problem, and at the present time are working on this aspect to determine whether the method has any potential value in the determination of liver pathology.

SUMMARY

A new method of "trap" venography has been described. It has been used in the laboratory in a series of thirty dogs. Designed primarily to provide a simple method of visualizing both portacaval and splenorenal shunts, it has been used in this instance in 15 dogs with absolute success. It has been used additionally for pelvic venography, hepatography, and demonstration of the vertebral venous pathways in another 15 dogs. No serious complications have been demonstrated. We believe that the method has been amply studied in the laboratory and now upon acquisition of a suitable catheter deserves clinical trial to establish whether it will have any clinical value.

REFERENCES

1. Blakemore, A. H., and Lord, J. W., Jr.: The Technique of Using Vitallium Tubes in Establishing Portacaval Shunts for Portal Hypertension, Ann. Surg. **122**:476, 1945.

2. Welch, C. S., and Callow, A. D.: An Appraisal of Current Methods for the Treatment of Portal Hypertension, Rev. Gastroenterol. **17**:423, 1950.

3. Blakemore, A. H.: Indications for Portacaval Anastomosis, Surg., Gynec. & Obst. **84**:645, 1947.

4. Linton, R. R.: Selection of Patients for Portacaval Shunts, Ann. Surg. **134**:423, 1951.

5. Blakemore, A. H.: Portacaval Shunting for Portal Hypertension, Surg., Gynec. & Obst. **94**: 443, 1952.

6. Large, A.; Johnston, C. G., and Prechow, D. E.: The Portacaval Venous Shunt, Ann. Surg. **135**:22, 1952.

7. Allard, C. A.; Harper, E. R., and Johnson, A. L.: Method for Determining the Patency of a Splenorenal Anastomosis, Canad. M. A. J. **59**:570, 1948.

8. Fitzpatrick, H. F.; Blakemore, A. H.; Smythe, C. M., and Weismann, S. G.: Study of Portal Vein Pressure and Blood, S. Forum (1951) p. 161, 1952.

9. Giges, B., and Teschan, P. E.: Portal Circulation Time in Cirrhosis of the Liver Following Anastomosis, J. Lab. & Clin. Med. **40**:537, 1952.

10. Newman, H. F., and Cohen, I. B.: Estimation of the Portal Circulation Time, J. Lab. & Clin. Med. **34**:674, 1949.

11. de Almeida, A. D.: Contribuição para o estuda da prova do éter na avaliação da permeabilidade das anastamoses diretas entre o sistema porta e o sistema cava: nota prévia, Rev. med. e cir. São Paulo **10**:583, 1950.

12. Dotter, C. T.; Payne, M. A., and O'Sullivan, W.: Catheterization of the Portal Vein in Man Following Portacaval Anastomosis, Ann. Surg. **132**:310, 1950.

13. Farinas, P. L.: Abdominal Venography, Am. J. Roentgen. **58**:599, 1947.

14. Cooper, D. R.; Brown, R. C.; Hone, C. H., and Ferguson, L. K.: Splenoportography, Ann. Surg. **138**:582, 1953.

15. Tori, G., and Scott, W. G.: Experimental Method for Visualization of the Hepatic Vein—Venous Hepatography, Am. J. Roentgenol. **70**:242, 1953.

16. Moretz, W. H.; Naisbitt, P. H., and Stevenson, G. P.: Experimental Studies on Temporary Occlusion of the Inferior Vena Cava, Surgery **36**: 384, 1954.

17. Miller, G. M.; Wylie, E. J., and Hinman, F.: Renal Complications from Aortography, Surgery **35**:885, 1954.

18. Batson, O. V.: The Function of the Vertebral Veins and Their Role in the Spread of Metastases, Ann. Surg. **112**:138, 1940.

Arterial Embolectomy

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HUSHANG JAVID, M.D.
and
ORMAND C. JULIAN, M.D., Chicago

Evaluation of the surgical treatment of arterial embolism is almost impossible on a statistical basis. Proponents of the conservative treatment emphasize the high mortality associated with surgery, whereas the more surgical-minded point to limb survival and restoration of pulses as the basis for evaluating surgical results. As in the analysis of all types of treatment the selection of cases is, of course, very important. The group of patients having arterial emboli of necessity carry a high mortality with or without any form of surgical therapy. The difference between success and failure in the surgical treatment of these patients is more often related to the degree of cardiac compensation and the degree to which the embolism itself contributes to cardiac failure rather than the technical procedure itself. One of the best surveys on a series of unselected cases of arterial embolism is that by Haimovici.[1] These cases were analyzed regardless of the type of therapy. More recently Warren and others [2] have shown an increased percentage of limb survival with a more positive approach to arterial embolism.

Advocates of conservative therapy base their opinion on the fact that spontaneous recovery after acute embolic obstruction of a vessel is observed in a certain proportion of cases. These apparent recoveries occur usually through one of two mechanisms. The first occurs particularly in the upper extremity where the collateral circulation is good and regains its maximum function after relief of vascular spasm. The second type of recovery is seen where the obstruction at an arterial bifurcation is partial. This partial obstruction plus vascular spasm may produce an apparent complete obstruction. Relief of spasm may provide a channel adequate for return of pulses, or the embolus may be dislodged into one of the branches, the other being adequate to supply the extremity.

The majority of emboli may be removed under local anesthesia, and the additional shock of the surgery is minimal. When the aortic bifurcation is involved, however, and general or spinal anesthesia is required, the decision to carry out surgery on the acutely decompensated cardiac patient may require more deliberation. As is often the case in aortic bifurcation emboli, the outlook may be extremely poor with or without surgery.

Another factor in the decision to operate on a case of acute arterial obstruction is the difficulty in distinguishing embolism from thrombosis. This is particularly true in the older patients where there is no obvious source of an embolus. With an adequate history of previously decreased or absent pulses in the involved extremity, plus a history of claudication and arterial insufficiency in the opposite extremity and evidence of generalized arteriosclerosis, the diagnosis of thrombosis, of course, is favored. However, in the majority of cases seen as an emergency one does not have records of previous pulses, and we have found age and mode of onset of symptoms to be very misleading. As a result, we believe all cases should be explored if there is any element of doubt as to differentiation between throm-

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bosis and embolus. This principle, which has been followed in the cases to be presented in this paper, will, of course, lead to over-all lowering of successful embolectomies.

While, as mentioned earlier, the evaluation of any type of treatment for arterial embolism is difficult, we believe, in the light of our experience, that the following premises are justified. 1. An acute arterial obstruction unrelieved by the release of arterial spasm should be surgically explored, particularly when it can be done under local anesthesia with little risk to the patient. This should be done for two reasons, namely, the prediction of survival of limb without surgery is sometimes very difficult, and if the limb does survive it will be arterially insufficient. 2. Recovery may be spontaneous after acute arterial obstruction due to emboli. Such recovery occurs most often in the arm and has led many not to operate upon arterial emboli in the upper extremity. It would seem to us that the same principles are involved as in the lower extremity, and for that reason we believe most emboli should be removed from the upper extremity. Gangrene does occur there, although certainly it is rare. 3. Since the differentiation between thrombosis and embolism as a cause of acute arterial obstruction is often quite difficult, for that reason operation under local anesthesia is far preferable to missing an operable embolus. 4. Aortic bifurcation embolism constitutes a separate problem because of the need of general or spinal anesthesia. This is particularly true in the critical cardiac patient. However, surgical exploration should be undertaken if at all possible, since survival of limb or life is rare without it. 5. Emboli may be removed at a later time if the collateral circulation has preserved the extremity at the initial episode.[3]

The cases presented in this paper represent private patients and patients in a large teaching institution. Surgery was performed both by the authors and by the residents on the vascular service. A total of 65 embolectomies were performed on 57 patients during the years 1947 through 1953. The series represents a positive surgical approach to arterial embolism, and embolectomies were attempted in many cases in which the general condition of the patient was extremely precarious. Many of them occurred in the older age groups.

The details of the diagnosis of acute arterial obstruction will not be reiterated here, with the exception of the following points. Embolism superimposed on a previously chronically obstructed artery usually gives less dramatic symptoms than acute arterial obstruction in an otherwise normal artery. Sensory loss and paralysis are often the best indication of the severity and age of obstruction. In this series arteriosclerotic thrombosis was encountered in five cases operated on. In all of these the attempt to restore circulation failed. Palpation of pulses and the use of the oscillometer usually are all that is necessary to determine the level of obstruction. We have used arteriography in only a few isolated cases and believe it is unnecessary in most instances. Occasionally the level of obstruction may not be at the usual larger bifurcation, such as the femoral or popliteal, but may occur, for example, in the lower part of the femoral artery. This is particularly true where a large number of small fragments have been released and the artery is actually packed with old clots for a considerable distance. The oscillometer will usually indicate the level of obstruction. One such case will be outlined in detail. An acute thrombophlebitis superimposed on arteriosclerosis obliterans may simulate an acute arterial obstruction. The lumbar block is of great value in such cases. On a number of occasions we have seen cases of cerulea phlegmasia dolens considered as possible acute emboli because of the presence of a cold, pulseless leg. The differentiating points here, of course, are the extreme blueness of the leg and massive swelling within a few minutes, both of these being good evidence of massive venous thrombosis. One of the most interesting conditions simulating an acute embolic obstruction is that of dissecting aneurysm. We have had the opportunity to observe six such cases in which the initial diagnosis was acute arterial obstruction of

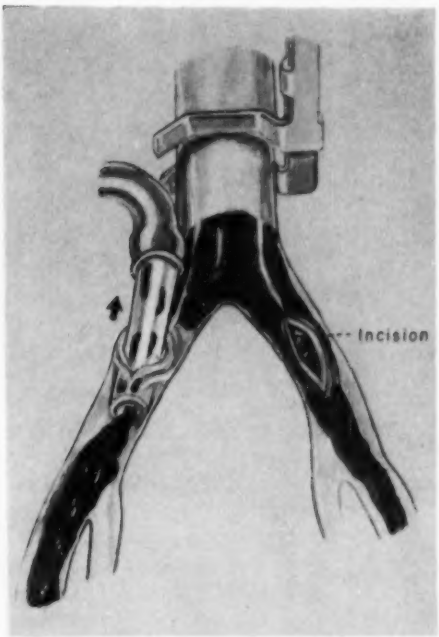
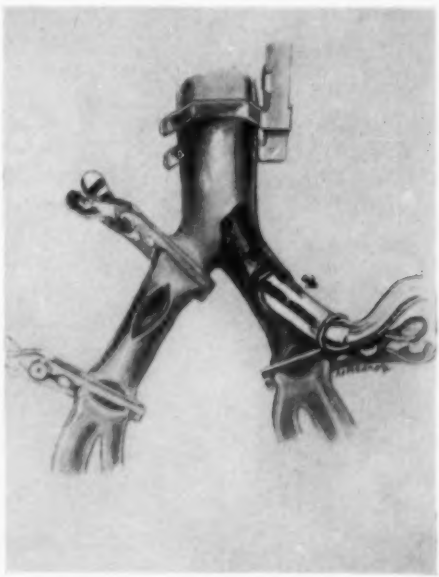


Fig. 1.—Aortic bifurcation embolectomy. Incisions are made in both common iliac arteries, and the distal propagating thrombus is aspirated first.

the lower extremities. The most important clinical finding in these cases was the level of anesthesia being considerably higher than the level of cold demarcation. The level of anesthesia from the high dissection of the aneurysm may be as high as D 10, whereas the cold demarcation level may be somewhere in the region of the knee or lower. This, correlated with the other points in the history, helps to differentiate the two conditions.

The surgical approach to peripheral emboli has been fairly well standardized. Some consideration will be given here to the surgical approach to aortic bifurcation emboli and also to the particular case in which emboli are packed into an artery away from the usual bifurcation for some distance. Spinal anesthesia has been used in surgery of aortic bifurcation emboli. In the older age group there may be evidence that the obstruction may be a thrombosis of a previously chronically occluded bifurcation of the aorta. Here we have made incisions in the femoral region under local anesthesia, inspected the femoral artery, noted the extensiveness of the disease, and then made our decision as to whether abdominal exploration of the aorta should be carried out. In the usual aortic bifurcation embolectomy in which the diagnosis is secure, exploration has been carried out through the abdomen via a left paramedian incision, with the patient under spinal anesthesia. After dissection of the aorta, proximal control is obtained with a Southwick clamp. The iliac arteries are then dissected out and control tapes placed. Separate arteriotomies are then made in each common iliac. The distal arteries are aspirated first, and then both common iliacs aspirated superiorly into the aorta successively. Control of the blood flow above usually is accomplished by a small Potts bulldog clamp placed just above the arteriotomy wound in the iliac. After suction of both iliacs superiorly, the blood is allowed to escape momentarily on both sides to flush out all the small clots. We feel this is somewhat superior to the one incision in the aorta

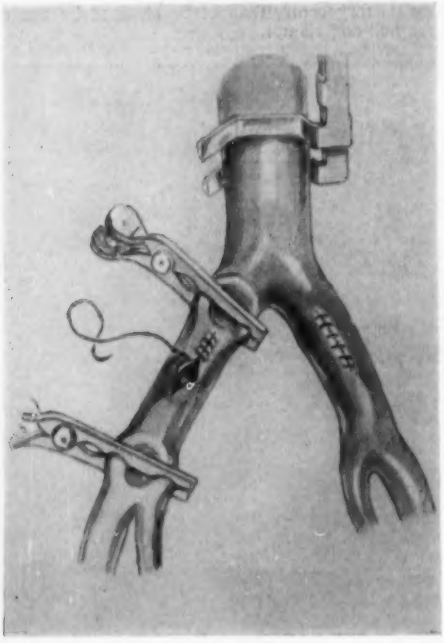
Fig. 2.—The embolism is aspirated proximal to each iliac incision, and control of the vessels is obtained by use of bull-dog clamps. The Southwick clamp above on the aorta proper is only used if satisfactory control cannot be obtained by use of the bull-dog clamps.



proper, since adequate control can be had to prevent dislodgment of any clot inferiorly into the distal arteries. The Southwick clamp superiorly is not closed unless adequate control cannot be obtained with bulldog clamps just above the iliac arteriotomy wounds (Figs. 1, 2, and 3). Heparin is instilled distalward through the arteriotomy wound by means of small polyethylene catheters.

On rare occasions the embolus is not lodged at a usual bifurcation. In one of our cases, the artery was obstructed in Hunter's canal for a distance of 4 to 5 in. (10 to 12.5 cm.), the clot extending down to approximately an inch (2.5 cm.) above the bifurcation of the popliteal artery. This clot was all old and apparently was a "packed embolus" consisting of a number of small fragments. In such cases a single arteriotomy wound over the superior part of the clot may be insufficient for the clearance of the entire artery. The embolus may be packed quite tight, and suction above will not remove it all. In one such case there was a fresh propagating thrombus below the packed embolus which extended into the posterior tibial artery as well. This case was handled (Fig. 4) by two separate arteriotomy wounds in the femoral and popliteal arteries, suction at either end aided by manual expression of the clot. The propagating thrombus below in the posterior tibial artery could not be aspirated from above, and this was cleared out by use of a catheter entering the artery below through a small transverse nick in the posterior tibial artery. A No. 5 ureteral catheter was passed from below, and

Fig. 3.—The arteriotomy wounds are closed by continuous 00000 nonabsorbable (silk) suture, after heparin has been instilled distally.



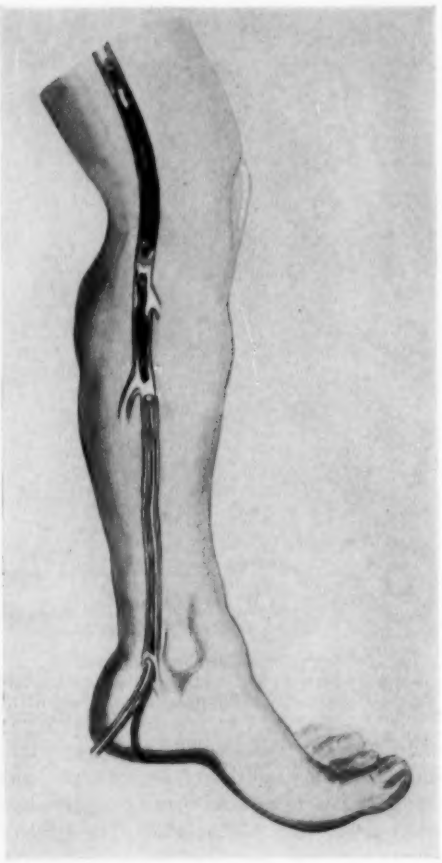


Fig. 4.—The embolus is "packed" in the artery above the bifurcation of the popliteal, necessitating two arteriotomy wounds to remove the embolus completely from the lower femoral and popliteal artery. The distal propagating thrombus was removed both from above and also by catheterizing the posterior tibial artery and flushing it out from below with heparin solution.

irrigation of the artery with heparin-saline was carried out until the vessel was entirely clear. This procedure resulted in return of blood flow to the ankle in this case.

RESULTS

Sixty-five embolectomies were performed in 57 patients. Thirty-eight embolectomies in 33 patients were successful; i. e., pulses were restored. Twenty-seven embolectomies in 24 patients were listed as failures (Table 1). Included in these 27 failures are 6 which were technically successful insofar as the removal of the embolus and immediate restoration of pulses were concerned but in which the patient died at periods of five days to five months after surgery (Table 2). There were 20 deaths in all, 14 occurring in the immediate postoperative period and 6 within six months after surgery (Table 3). It will be seen in Table 4, where a summary of the technical successes and technical failures is given, that the largest number of deaths occurred in the technical failure group. It is our impression that the failures were related, at least in our particular series of cases, more to the precarious cardiac status of the patient at the time of surgery than to any other factor. The time interval from the onset of the embolus is important, as shown in Table 5, where it will be noted that 34 of the successful cases were operated on within the first 12 hours. However, as noted in Table 6 there were 17 failures in patients seen within the first 12 hours after onset. These patients were all in a poor state

TABLE 1.—*Summary of Embolectomies*

Patients, No.	Success	Failure
57	38 (33 patients)	27 (24 patients)

TABLE 2.—*Causes of Death in Technically Successful Cases*

Postoperative Interval	Cause of Death
5 days	Heart failure
10 days	Coronary occlusion
20 days	Cardiac arrest
1 mo	Cerebrovascular accident
3 mo	Heart failure
5 mo	Coronary occlusion

TABLE 3.—*Causes of Death*

Causes	No. of Cases
Heart failure	12
Acute coronary occlusion	3
Cerebrovascular accident	2
Retroperitoneal hemorrhage	1
Uremia	1
Thrombosis aneurysm of bifurcation of aorta	1
Total	20

TABLE 4.—*Summary of Embolectomies*

Technical Successes		Technical Failures	
Deaths	Living	Deaths	Living
5	33	14	4

TABLE 5.—*Time Interval of Successful Cases*

	Cases, No.
12 hr	34
4 days	1
6 days	1
3 wk	1
3 mo	1
Total	38

TABLE 6.—*Time Interval of Failures*

	Cases, No.
12 hr	17
18 hr	4
24 hr	3
30 hr	1
48 hr	1
4 mo	1
Total	27

TABLE 7.—*Location of Emboli*

	Success	Failure
Subclavian	1	..
Axillary	2	1
Brachial	9	1
Aortic bifurcation	2	3
Common iliac	..	4
External iliac	1	2
Femoral	16	7
Popliteal	7	9
	38	27

of cardiac compensation at the time of surgery. As in most series, the majority of the peripheral emboli occurred in the femoral bifurcation (Table 7). We have operated upon almost all of the upper extremity emboli, as contrasted to Lord.[4] In addition, we have explored for popliteal emboli, where the percentage of failure was the highest, namely nine failures as contrasted to seven successes. Warren and others[2] state that they treat popliteal emboli conservatively and show good salvage of limb with this approach.

In regards to age, 38 of the patients were over 50 years of age. Of these 38, 19 were successful. Of the 19 that were unsuccessful, 15 died in the immediate postoperative period or within six months after surgery.

Six aortic bifurcation embolectomies have been done, with only three successes. The failures occurred in patients with severe cardiac decompensation. All three of these patients died postoperatively in heart failure.

TABLE 8.—*Aortic Bifurcation Embolectomies*

Age	Time Interval	Results	Cause of Failure
45	10 hr.	Failure	Died in heart failure
42	8 hr.	Success	.....
61	8 hr.	Success	.....
45	4 mo.	Failure	Died in heart failure
60	36 hr.	Failure	Arteriosclerosis; died in heart failure
52	11 hr.	Success	.....

In the three successful cases the patients were operated upon within 12 hours of the onset and operation resulted in restoration of pulses distally (Table 8).

SUMMARY

Experience with 65 embolectomies in 57 patients is presented.

Thirty-eight successes and 27 failures are recorded.

The cardiac status of the patient at the time of surgery is emphasized as an important factor in the failures.

The cases presented represent a positive surgical approach regardless of age or position of the embolus.

Of the 24 patients in whom operation resulted in failure, only 4 were living at the end of six months postoperatively.

REFERENCES

1. Haimovici, H.: Peripheral Arterial Embolism, Angiology **1**:20-45, 1950.

2. Warren, R.; Linton, R. R., and Scannell, J. G.: Arterial Embolism: Recent Progress, Ann. Surg. **140**:311-317, 1954.

3. Olwin, J. H.; Dye, W. S., and Julian, O. C.: Late Peripheral Arterial Embolectomy, A. M. A. Arch. Surg. **66**:480-487, 1953.

4. Lord, J. W.: Surgical Therapy of Acute and Chronic Arterial Occlusion, Bull. New York Acad. Med. **28**:259, 1952.

DISCUSSION

ON PAPERS BY DRS. GIUSEFFI AND LARGEN AND DYE, OLWIN, JAVID, AND JULIAN

DR. BEN EISEMAN, Denver: I should like to discuss the very interesting paper by Drs. Giuseffi and Largen.

We too are interested in this problem of determining the patency of portacaval and splenorenal shunts and have used two methods that may be of interest to the Association.

First is the use of the oral ammonium-citrate-tolerance test, which is based on the fact that ammonium citrate absorbed from the intestinal tract and carried via the portal vein to the liver causes no rise in peripheral blood ammonia levels. If, on the other hand, a patent portacaval shunt exists, high concentrations of ammonia are emptied directly into the vena cava and cause a marked rise in peripheral blood ammonia concentration.

We have carried out this test on 14 dogs and eight patients with portacaval shunts and have found that the pattern of the blood ammonia levels following the oral ingestion of ammonium citrate indicates the patency or closure of the venous shunt as verified by splenoportography or at the time of reexploration.

We have also used Murray's technique on three patients, whereby vena caval blood samples are taken above and below the entrance of the shunted portal blood following the ingestion of a concentrated glucose solution. The samples thus obtained via a small Polythene tube threaded up the femoral vein show a marked rise in glucose concentration as the site of the patent shunt is reached.

DR. W. KENNETH JENNINGS, Santa Barbara, Calif.: I wish to refer to Dr. Dye's presentation simply by adding a quite recent case of successful aorta bifurcation embolectomy.

Three weeks ago we examined a 45-year-old woman who a year earlier had undergone a mitral commissurotomy. Some three hours before we saw

her she had suddenly developed signs and symptoms of complete occlusion of both iliac arteries.

She was taken to the operating room, where the abdomen was opened, approximately four hours after the onset of symptoms, and a saddle-type embolus was removed. We used almost exactly the same technique as described by Dr. Dye.

[Slide] Here are the aorta and the two iliac arteries. These are the silk suture lines in the iliac arteries.

This woman was ambulatory on her second postoperative day and was able to leave the hospital on the eighth postoperative day. We saw her last week, at which time the circulation to both extremities apparently had been completely restored.

DR. EUGENE A. OSIUS, Detroit: Mr. Chairman and fellow colleagues: I would like to praise Dr. Dye and his group for a very nice presentation of a very important subject, one which I think is becoming more and more important as time goes on, owing to the fact that people are living to an older age and we are going to expect to have more of these catastrophes occur. They are real catastrophes, as anyone can attest who has seen any number of them.

I quite agree with many of the statements that Dr. Dye made—first of all, that these patients are in extremely poor condition and you have to accept a rather high mortality at the start.

I was interested in Dr. Dye's statement of dissecting aneurysms. Having seen a patient a year or two ago who presented a typical picture of a femoral embolus, I took the patient to the operating room and under local anesthesia I explored the femoral, as Dr. Dye suggested. As I made the incision into the femoral artery, much to my dismay the blood spurted practically sky high, which was very discomforting from the standpoint of diagnosis but rather pleasing from the standpoint that the man still had blood going into his extremity. He died about 24 hours later with a dissecting aneurysm. He had absent pulses on that side. This is something to watch for and to be on guard against. The only clue we had in this patient was that about eight hours after operation he began to have some back pain which he had not had previously. It had nothing to do, of course, with the operation.

I think an aortic embolus, as has been pointed out, is an entirely separate lesion and has to be dealt with drastically and quickly and with a different set-up entirely, as Dr. Dye pointed out. There are several operative approaches. Some have approached it retroperitoneally, some transperitoneally, and some have advocated approach through the femorals. I tried one approach through the femorals with a negative zero result both as to getting the embolus and as to saving the patient. My own belief is that transabdominal is the best exposure.

We have had five cases to date, and we are just half as good as Dr. Dye, because we have only one patient living, but that patient has been alive for six years and has carried on a relatively useful life except for the fact that she has rheumatic heart disease and does decompensate from time to time.

She had the type of embolus which hit the bifurcation and then divided into two separate plugs, plugging both iliacs, and they were removed through the two incisions in the iliac vessels, as Dr. Dye has suggested.

I believe the aorta can be safely opened and the embolus removed, provided it is located at the bifurcation and does not extend too far down into the iliacs.

Once more I should like to commend the essayists and also to put in a plea for further study by every surgeon on the subject of arterial emboli. It is something that everyone may meet. I heard a remark made some months ago, "Who is going to do an aortic embolus? Why pay too much attention to it?" It is something that anyone can meet; anyone may have to face it, and while the salvage percentage is low I think that with the increased interest and teaching in vascular disease, which has been coming forth in the last 20 or 25 years, and the training of men in the handling of these emergencies, the percentage of good results can definitely be increased and more patients can be saved than we have saved in the past.

Thank you very much.

DR. ROBERT A. WISE, Portland, Ore.: I, too, have enjoyed Dr. Dye's presentation of this very important subject. I would like to add briefly the thought that we should also become interested in embolic occlusion of other than the peripheral arteries.

This brings to my mind a very dramatic case that we had at the Portland Veterans Hospital some four years ago, in which the superior mesenteric artery was occluded and the embolus successfully removed by Dr. Kean F. Westphal, a member of our surgical staff. The patient was 65 years of age and was convalescent from a gastric resection. He developed a coronary occlusion on the seventh postoperative day, and seven days later he developed the unmistakable signs of an acute surgical abdomen.

Upon exploration of his abdomen the small intestine from a point 10 in. distal to the ligament of Treitz and the large intestine, including the cecum, ascending colon, and hepatic flexure, were slate gray. There were no pulsations of any of the mesenteric vessels. They were represented as darkened, nonpulsating strands.

The superior mesenteric artery was exposed at the base of the mesentery, and a hard, occluding mass in this artery was palpated at a point just below the origin of the middle colic artery.

[Slide] This is the superior mesenteric artery with tapes about it. You will note the arteriotomy incision and a catheter used for suction in removing the embolus.

[Slide] This is the embolus that was removed from the superior mesenteric artery.

Following the removal of this embolus and the suture of the arteriotomy wound, the small and large intestines assumed normal color with the exception of one segment about 14 in. in length in the midileum. This segment was resected.

The patient was seen three and one-half years after the procedure, at which time his general condition was excellent.

I thought you would be interested in the possibility of successful removal of an embolus of the superior mesenteric artery.

Thank you.

DR. EUGENE A. OSIUS, Detroit: I would like to rise to praise Dr. Wise for this reason: To the best of my knowledge, that is the third superior mesenteric embolectomy that has been successful, in the literature. There is one reported from Sweden and one by Dr. Alan A. Klass, of Winnipeg, Canada, and this is the third. I say it feelingly because we failed to recognize one such case which occurred in a patient in whom we did a successful femoral artery embolectomy.

Tolerance of the Hypothermic Normal Dog's Heart to Ventricular Fibrillation

MAJOR PAUL W. SCHAFER
LIEUT. COL. CARL W. HUGHES
and
CAPT. TIMOTHY G. BARILA (MC), U. S. Army

Interest in hypothermia continues to enlarge, and, with demand for its increased clinical application, laboratory investigations of its effects are being pursued over an ever-broadening range.* The experiments to be described in this report constitute in effect part of a control experience for current and projected researches at the Army Medical Service Graduate School. Generally the clinical use of hypothermia has been limited by the specter of ventricular fibrillation. Much has been written concerning the many factors believed to influence its occurrence, but only limited information is available concerning its significance.†

From the 53 healthy adult mongrel dogs which constitute the basis for this study we have attempted to learn something of the over-all effect of ventricular fibrillation as it occurs spontaneously at reduced levels of body temperature.

Each animal was intubated under light sodium pentobarbital anesthesia, 25 mg/kg. of body weight being employed. Artificial respiration was established at 20 strokes per minute at a volume calculated to produce moderate hyperventilation, after which the animal was cooled by immersion in an ice water bath at just above 0 C. Femoral artery blood pressure and a standard three-limb lead electrocardiogram were recorded throughout the acute experiment. Body temperature was measured with an inlying rectal thermometer.

Under these conditions hypothermia was quickly established, the rectal temperature falling about 1 degree centigrade each five minutes (Fig. 1). As may be seen from the accompanying figure, ventricular fibrillation supervened over the wide range of 27 to 13.5 C, with an over-all average of 20.7 C. A similar decline was observed in femoral arterial blood pressure and in pulse rate, the average level at time of fibrillation being 76/50 mm. Hg at a rate of 32 per minute (Fig. 2). The slowed propagation of the cardiac impulse is indicated graphically in Figure 3. At time of fibrillation the P-R

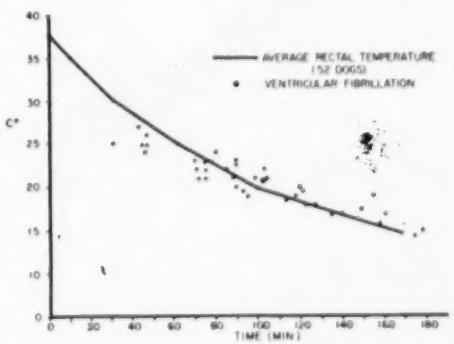


Fig. 1.—Fall in rectal temperature resulting from immersion in an ice-water bath at near 0 C, with an indication of the wide range over which ventricular fibrillation began.

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 2, 1954.

From the Division of Surgery, Army Medical Service Graduate School, and the Thoracic and Cardio-Vascular Service, Department of Surgery, Walter Reed Army Hospital, Walter Reed Army Medical Center.

* References 1 to 3.

† References 4 to 14.

interval had lengthened to an average of 0.21 sec., the QRS segment to 0.13 sec., and the Q-T interval to 0.82 sec. Though auricular fibrillation was rarely seen, at very low body temperatures complete cessation of auricular beat with the development of idioventricular rhythm was often observed. Gross wave-form distortions were regularly seen, particularly in the S-T segment and in the T wave. Representative examples are illustrated in Figure 4. All of the animals here reported went directly from rhythmic beat into ventricular fibrillation, cardiac standstill not being observed except in a few instances after several hours of fibrillation. Several times a very slow rhythmic rate was observed

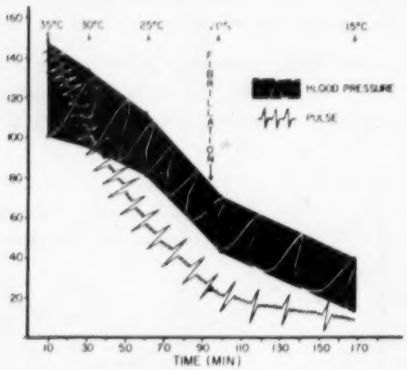


Fig. 2.—Average decline in blood pressure and pulse rate observed in the entire series of animals included in this report. Average values at time of fibrillation were 76/50 mm. Hg at a rate of 32/min.

for a prolonged period before ventricular fibrillation occurred, one animal having a rate of three regular beats per minute for over an hour prior to spontaneous fibrillation. Spontaneous recovery from fibrillation was not observed.

The first six animals in this series were simply cooled to an average temperature of 22 C, after which they were rewarmed in a water bath at 45 C. One fibrillated at 22 C, and no attempt was made to effect salvage. The remaining five animals survived without complication. To more nearly approximate later test conditions, the next six animals were cooled to an average of 21 C, at which

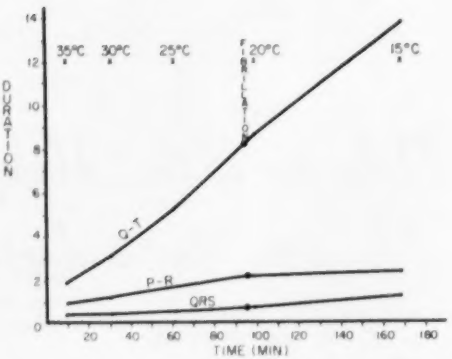


Fig. 3.—Average electrocardiographic measurements for the entire series of animals. Duration is plotted in tenths of a second.

temperature they were held for a period of one hour with an open thoracotomy, after which they were rewarmed. One animal fibrillated at 22 C but was promptly resuscitated. One animal was lost, owing to premature extubation. The other five were long-term survivors without complications.

The remaining 41 animals were cooled until ventricular fibrillation occurred and then were allowed to chill without disturbance for periods ranging from 15 minutes to 5 hours. At the end of this prescribed interval the chest was quickly opened and rhythmic manual compression of the heart was begun. An average artificial pulse rate of 100 per minute with an average blood pressure of 100/60 mm. Hg was established and maintained by this method. Warming was accomplished by placing the animal on

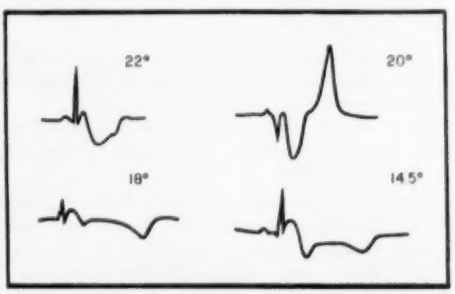


Fig. 4.—Examples of distorted electrocardiographic wave-forms observed at the temperatures indicated.

Duration Fibril. (Min.)	No. of Dogs	Fibril. Onset Temp., C			Low Temp., C			Defibrillation Temp., C			Defibrillation Time, Min.			Result
Control 1	6	22	..	..	23	22	22	..	..	..	..	..	..	Five survived without complication; no effort made to salvage one dog which fibrillated
					22	21	..	..	..	..	..	..	..	
Control 2	6	22	..	..	22	22	21.5	..	..	..	..	..	..	Five survived without complication; one lost due to premature extubation
					21	21	19.5	22	..	..	5	..	..	
15	6	24	22	22	22.5	22	21.5	25.5	22	21.5	60	29	16	Five survived without complication; one not salvaged due to lack of hot saline
		20	17	16.5	20	16.5	15	21	19.5	..	13	9	..	
30	6	23	21	21	23	20	19	29	25.5	23	32	21	12	Five survived without complication; one killed on 9th day—skin breakdown on back
		20	17.5	15	17	16	13	19.5	17	16	9	9	4	
45	3	25	23	22.5	22.5	21.5	21.5	27	25	22.5	18	13	13	Two survived without complication; one died overnight—tension pneumothorax
60	3	20	18	17	16	14.5	14	25	17	17	40	31	15	One survived without complication; one died 2d night—pneumothorax and atelectasis; one died overnight—tension pneumothorax
75	3	25	18	14.5	17	15.5	11	23	19	18	40	21	12	One survived—slight persistent hind-quarter weakness; two died overnight—tension pneumothorax
90	3	27	24	16	22	19	15	30	23	20	34	20	4	One survived—slight persistent hind-quarter weakness; one died 2d night—coronary thrombosis? One killed 2d day—tension pneumothorax
105	4	23	21	19	20	18	17	29	25	24	81	12	10	Two killed 9th and 10th days—could eat but not stand; two died 3d and 4th nights—coma and convulsions
		13.5	..	..	11.5	..	..	21	..	..	2	..	..	
120	3	25	23	21	17.5	17	15.5	30	27	23	93	29	13	One killed, 3d day—coma and convulsions; two died few hours after acute experiment (cause?)
180	4	20	19.5	19	14	12.5	12	26	24	19	48	25	19	One killed, 3d day—blind and convulsive; one died few hours after acute experiment (cause?); two failed to survive acute experiment—one refibrillated, one could not maintain blood pressure
		18	..	..	11	..	..	16	..	..	3	..	..	
240	3	21	19.5	18.5	12.5	11	10	24	21	..	69	65	..	One died overnight (cause?); one could not maintain blood pressure and thus did not survive the acute experiment; one could not be defibrillated
300	3	26	25	22	12.5	12	10	26	21	13.5	45	25	17	All three defibrillated and had good gross cardiac action and electrocardiograms, but none could maintain adequate blood pressure, and thus none survived the acute experiment

a hot water mattress and by irrigation of the pleural spaces with sterile saline at 45 C. With each 1 C rise in rectal temperature a single defibrillation shock of 200 volts was administered to the heart for a period of 0.13 sec. This routine was continued until defibrillation occurred and the animal established its own adequate circulation. Warm saline irrigation was continued until a rectal temperature of 28 C was reached, at which time the chest was closed. The acute phase of the experiment concluded when normal vital signs were present.

Observed results are recorded in the accompanying Table. Here it will be noted that the low temperature ranged from 23 to 10 C, with an average of 15.4 C. Rewarming occurred at a variable rate, depending in large part on the size and body structure of the dog, roughly parallel to the rate of cooling. The average rate of rewarming prior to defibrillation was 6.6 C/min. Defibrillation was accomplished over the range of 13.5 to 30 C, with an average of 19.9 C.

Our study of the effects of the first hour of fibrillation began with six animals which were allowed to fibrillate for 15 minutes after onset at an average temperature of 20.6 C. One was lost owing to inadequate preparations for rewarming; however, the other five survived without complications. The next six animals fibrillated for 30 minutes. All survived, five without complications. The remaining animal was killed on the ninth day in good condition except for an area of skin breakdown on the back. One of three animals allowed to fibrillate for 45 minutes died during the first postoperative night and at autopsy was found to have a tension pneumothorax. The other two animals had slight hind-quarter weakness for the first three postoperative days but otherwise had no complications. Pneumothorax and atelectasis also caused the death of two of the animals allowed to fibrillate for 60 minutes, one on the first and one on the second postoperative night. The third animal survived without complication.

We had expected that with 60 minutes of fibrillation we would have encountered serious vital organ defects. Yet of 18 animals having been allowed to fibrillate for from 15 to 60 minutes all had defibrillated easily and had recovered perfectly from the effects of the acute experiment, save one for which adequate preparations had not been made for rewarming. The three deaths due to tension pneumothorax we believe could have been prevented without too great difficulty. The one animal killed on the ninth day with an area of skin breakdown was in otherwise good condition and could have been salvaged with prolonged local care of its skin lesion. The 13 long-term survivors were in as good condition as before the experiment.

We thus undertook study of the second hour of fibrillation. Pleural space complications continued to mar the result that otherwise could be obtained. Two of three animals survived 75 minutes of fibrillation in excellent condition, only to be lost during the first postoperative night, whereas the third survived with only the slightest persistent hind-quarter weakness. Similarly, one of the three dogs which fibrillated for 90 minutes had to be killed during the day after operation because of a recurrent tension pneumothorax. One died during the first postoperative night and was one of the two animals in the entire series found at autopsy to have a coronary artery thrombosis, though this alone did not appear to be a sufficient cause of death. The third dog survived in good condition, with only a slight persistent hind-quarter weakness. At 105 minutes of fibrillation we for the first time encountered some of the complications we had expected to see much earlier. All four animals in this group went easily through the acute experiment and presented no cardiovascular problems. Two died during the third and fourth postoperative nights after persistent coma and repeated convulsions. The other two were killed on the 9th and 10th days, respectively. They appeared to have suffered considerable cerebral damage. Both were blind and, though they could eat and drink, neither could stand upright. With two hours of fibrillation we could still easily resuscitate

all three animals. Two, however, died a few hours after the acute experiment, and the cause could not be definitely established. One survived in a comatose condition and was finally killed on the third postoperative day with an unmanageable tension pneumothorax.

Thus, even after two hours of fibrillation, we had yet to encounter a failure in defibrillation or in complete resuscitation, and though serious and lethal complications were regularly being encountered, the heart and circulation were not defective. Thus we began to explore the effect of several hours of fibrillation. Four animals were allowed to fibrillate for three hours. All defibrillated. Two died during the acute experiment, one with an unsalvageable recurrence of fibrillation and one which, though it did not refibrillate, was unable to maintain an adequate blood pressure. One died of undetermined causes during the first night after perfect recovery from the acute experiment. The fourth dog was killed on the third day with persistent coma, recurrent convulsions, and apparent blindness. After four hours of fibrillation we encountered in one animal the only failure in defibrillation in the entire series. One other animal did not survive the acute experiment owing to failure to maintain adequate unassisted blood pressure. After a perfect recovery from the acute experiment the third animal died during the first postoperative night with cause undetermined. To date we have not explored the area beyond five hours of fibrillation since, though all three of these animals defibrillated and had good gross cardiac action and electrocardiographic tracings, none was able to maintain adequate blood pressure and thus none survived the acute experiment.

SUMMARY

Under the conditions of this experiment, normal adult dogs were found to survive up to 60 minutes of ventricular fibrillation with complete recovery. After 75 and 90 minutes of fibrillation, survivors were found to have only a mild persistent hind-quarter weakness. The last half of the second hour of fibrillation resulted in signs of severe cerebral damage. After three, four, and five hours of fibrillation, resuscitation became increasingly difficult, and after five hours no dog survived the acute experiment. We have not yet searched for the limit after which defibrillation is impossible.

We are loath to draw conclusions from these observations, since the rapidly enlarging literature of hypothermia is already replete with conclusions, some of which are difficult to correlate. This probably relates mainly to the widely varying circumstances under which observations have been made. We have dealt exclusively with normal adult dogs observed under a very rigid experimental protocol. Suffice it for us now to say simply that under these conditions it does not appear that ventricular fibrillation, at least so far as the heart is concerned, is necessarily a limiting factor and that perhaps we should increasingly think of the onset of fibrillation as an overture to further investigation rather than as a limit within which we must carry out the search.

REFERENCES

1. Swan, H., and Zeavin, I.: Cessation of Circulation in General Hypothermia: III. Technics of Intracardiac Surgery Under Direct Vision, Ann. Surg. **139**:385-396, 1954.

2. Bailey, C. P.; Cookson, B. A.; Downing, D. F., and Neptune, W. B.: Cardiac Surgery Under Hypothermia, J. Thoracic Surg. **27**:73-95, 1954.

3. Lewis, F. J., and Taufic, M.: Closure of Atrial Septal Defects with the Aid of Hypothermia: Experimental Accomplishments and Report of One Successful Case, Surgery **33**:52-59, 1953.

4. Swan, H.; Zeavin, I.; Holmes, J. H., and Montgomery, V.: Cessation of Circulation in General Hypothermia: I. Physiologic Changes and Their Control, Ann. Surg. **138**:360-376, 1953.

5. Juvenelle, A. A.; Lind, J., and Wegelius, C.: A New Method of Extracorporeal Circulation—Deep Hypothermia Combined with Artificial Circulation, Am. Heart. J. **47**:692-736, 1954.

6. Bigelow, W. G.; Mustard, W. T., and Evans, J. G.: Some Physiologic Concepts of Hypothermia and Their Applications to Cardiac Surgery, J. Thoracic Surg. **28**:463-480, 1954.

7. Swan, H.: The Current Status of Hypothermia (Editorial), A. M. A. Arch. Surg. **69**: 597-601, 1954.

8. Hoff, H. E., and Stansfield, H.: Ventricular Fibrillation Induced by Cold, Am. Heart J. **38**: 193-204, 1949.

9. Prec, O.; Rosenman, R.; Braun, K.; Rodbard, S., and Katz, L. N.: The Cardiovascular Effects of Acutely Induced Hypothermia, J. Clin. Invest. **28**:293-300, 1949.

10. Hegnauer, A. H.; D'Amato, H., and Flynn, J.: Influence of Intraventricular Catheters on the Course of Immersion Hypothermia in the Dog, Am. J. Physiol. **167**:63-68, 1951.

11. Brown, E. B., Jr., and Miller, F.: Ventricular Fibrillation Following a Rapid Fall in Alveolar Carbon Dioxide Concentration, Am. J. Physiol. **169**:56-60, 1952.

12. Osborn, J. J.: Experimental Hypothermia: Respiratory and Blood pH Changes in Relation to Cardiac Function, Am. J. Physiol. **175**:389-398, 1953.

13. Peirce, E. C., II., and Polley, V. B.: Differential Hypothermia for Intracardiac Surgery, A. M. A. Arch. Surg. **67**:521-525, 1953.

14. Ross, D. N.: Hypothermia: Part II. Physiological Observations During Hypothermia, Guy's Hosp. Rep. **103**:116-138, 1954.

Hypotension and Hypothermia in Surgery of the Thoracic Aorta

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Separately the adjuncts of hypotension and hypothermia have been demonstrated to be controllable and safe. Morris [1] induced controlled hypotension by the administration of hexamethonium and found that there was little evidence of cerebral or renal damage due to anoxia in patients kept in the supine position during the period of depression. In these subjects the mean blood pressure was lowered to 55 mm. of mercury. Anlyan [2] has studied the extent of liver damage incurred after hypotension induced by ganglion-blocking drugs. He and his co-workers compared the changes in liver function induced by hypotension produced by hemorrhage with that produced by ganglion-blocking agents. They reduced the blood pressure to a mean pressure of 30 mg. of mercury for 30 to 45 minutes in dogs by each method and found that the mortality rate was lower when the ganglion-blocking chemical drug was used to reduce the pressure. Histological changes in the liver were not marked except in the dogs that actually died during or after the period of hypotension.

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Clinical application of drug-induced hypotension in large blood vessel surgery has been made by Glenn and his associates.[3] They used this technique in patients having patent ductus arteriosus in whom the ductus was unusually large or the aorta enlarged and thin-walled adjacent to the ductus. Their series also includes a case of an ascending aortic aneurysm subjected to lateral aneurysmectomy. The purpose accomplished in their hands was the reduction in size and tenseness of the vessels involved, making clamp application safer. Hypotension has also been used alone for this purpose by ourselves [4] in resections of the aortic bifurcation. Complications due to the hypotensive state have not been encountered by Glenn, and none were seen in our previous series.

Fay and Henny [5] first introduced hypothermia in 1939 in the treatment of neoplasms. Many studies since this time puts in our hands much information pertaining to various characteristics of the hypothermic state. McQuiston [6] has pointed out the usefulness of hypothermic techniques during the surgical treatment of cyanotic heart disease in children. Extensive experimental studies in the use of hypothermia as an adjunct to cardiac surgery have been carried out by Bigelow and his associates[7] and others. These studies have outlined the dangers and limitations of the hypothermic state, and from them a uniformly safe lower limit of body temperature for conservative use may be selected.

Various methods of heat exchange have been used for cooling. Laborit and Huguenard [8] demonstrated that the rate of cooling by any method can be accelerated through the use of substances which block the vegetative nervous system. A mixture of drugs of the phenothiazine group was initially used

by these workers. Two features of the action of these drugs are that the autonomic blockade prevents overaction of the nervous system in an attempt to maintain a constant internal environment and that the resistance, particularly to temperature change, is so diminished as to render the body essentially poikilothermic.

Much use has been made of the technique of body cooling in open heart surgery to permit total circulatory occlusion for sufficient time to perform intracardiac surgery under direct vision.* Here, of necessity, the attention is focused on the effect on the heart and on the brain. Application of hypothermia to prevent anoxic changes in the spinal cord and other viscera during periods of thoracic aortic occlusion has been made by DeBakey and Cooley.† These authors have reported resection of an aneurysm of the distal aortic arch under hypothermia. The resection required 62 minutes of aortic occlusion proximal to the left subclavian artery. The patient's body temperature was at 82 F during this period.

TECHNIQUE OF HYPOTENSION

Controlled depression of the blood pressure was obtained in most of the cases by the use of camphor sulfonate (Arfonad).‡ The drug was administered intravenously as a 0.1% solution in 5% dextrose solution. This solution contains 1 mg. of camphor sulfonate per cubic centimeter of solution. Administration was begun at a rate of about 40 drops per minute (2-3 mg.). Adjustment of the rate of flow was governed by very frequent determinations of the blood pressure. When hypotension was no longer needed, administration of the drug was stopped and a fairly rapid return of the systolic pressure to previous levels was obtained. The rate of return of the blood pressure may be increased by rapid administration of 50-150 cc. of whole blood or a small dose of one of the vasopressors. Blood loss during the hypotensive period was very carefully observed, and replacement was kept as accurate as possible.

Camphor-sulfonate-induced hypotension was not accompanied by tachycardia in spite of its vagal blocking action. We have found the hypotensive effect of the drug to be very brief. Frequent consecutive blood pressure readings must be taken to follow the falling pressure. The rise in pressure which resulted from discontinuing administration was almost immediate. Vasodilatation, which was in part responsible for the hypotension, did not result in any increased bleeding tendency; the effect was actually to the contrary. In several instances the administration of camphor sulfonate was not needed to reduce the blood pressure to the desired levels. In these, a slight deepening of the level of anesthesia brought about a blood pressure fall in the patient under hypothermia.

TECHNIQUE OF HYPOTHERMIA

In the cases to be presented hypothermia was induced by the application of a cooling perfusion blanket or ice packs. Before the induction of anesthesia, all the patients were given a phenothiazine derivative (chlorpromazine §) because of its poikilothermic action. This series consists entirely of adults, and the chlorpromazine dosage ranged from 40 to 95 mg. and was administered intravenously. After the euphoria and drowsiness which the drug produces had become definite, anesthesia was induced either by intravenous thiopental (Pentothal) or nitrous oxide by mask. For the sake of comfort the patients were not placed on the perfusion blanket until just before induction. With the circulating fluid of the perfusion blanket at 34-36 F, body temperature measured rectally begins to fall in about 15 minutes. A less rapid and dependable fall in temperature has been obtained by ice packs. Depending somewhat on the amount of dissection anticipated before aortic occlusion could be applied, the operation was started after 15-30 minutes of cooling. The patient's body temperature was lowered to 82-86 F, where it was maintained during aortic occlusion. In the earlier cases presented here significant lowering was not obtained, as familiarity with the application and hazards of the technique was being developed. The use of chlorpromazine results in a relatively rapid and smooth fall in body temperature, and shivering rarely ocurs even though the anesthesia is kept light.

INDICATIONS FOR HYPOTENSION

The purpose of hypotension during cross clamping of the diseased aorta has already been mentioned. Its indication in nonobstructing lesions of the thoracic aorta and coarctation in adults is the same as that

* References 9 and 10.

† References 11 and 12.

‡ Arfonad: d-3,4(1'3'-dibenzyl-2'-keto-imidazolido)-1,2-trimethylenethiophanium d-camphor sulfonate.

§ 10-(3-dimethylaminopropyl)-2-chlorphenothiazine hydrochloride.

which has been reported in resection of lesions of the abdominal aorta. Coarctations in adults are always accompanied by a significant degree of arteriosclerotic change in the aorta proximal and even distal to the lesion. Clamp application is made less hazardous by hypotension.

INDICATIONS FOR USE OF HYPOTHERMIA

The clearest indication for hypothermia in surgery of the thoracic aorta is in the resection of lesions which are not themselves occlusive in nature. The greater freedom from ischemic damage to the spinal cord and other sensitive structures so far demonstrated in animals and in man during prolonged periods of aortic obstruction encouraged us to use hypothermia as the sole safeguard. The technical difficulties of temporary shunting are thereby avoided.

Resection of a coarctation in an adult patient gives rise to situations in which danger of distal ischemia is much the same as in resection of nonobstructive lesions. Even though a very adequate collateral circulation obviously has developed, the preparation for resection of the coarctation may require ligation of several pairs of large and valuable intercostal arteries. In an adult patient arteriosclerotic changes near the coarctation sometimes lead to a very high placement of the proximal occluding clamp so that the left subclavian artery is obstructed. Furthermore, when the head of pressure supplying the collateral arterial bed is dropped from hypertensive levels to 90-110 mm. Hg, the collateral efficiency undoubtedly suffers. A true impression of the incidence of ischemic cord damage in coarctation surgery is lacking, but where it occurs it no doubt may be explained by one or more of these mechanisms. Beattie [13] has described such an incident with fatal termination.

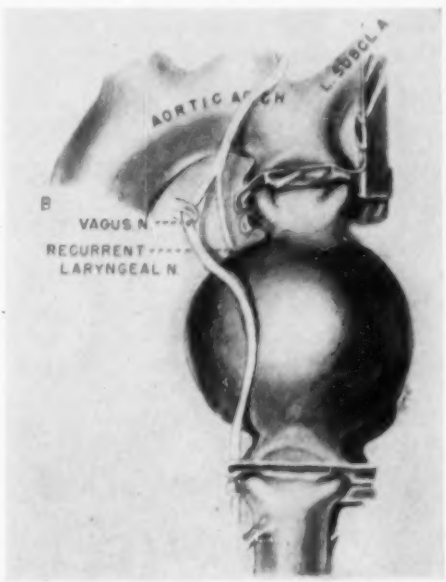
SURGICAL TECHNIQUE

Certain principles in technique have developed during the surgery in this series. The usefulness of grafts in repair of certain coarctations in children and in adults has been described by Gross and co-workers.[14] We believe that degenerative arterial changes, as an indication for use of a graft in adults, is as important as the length of the coarctation. This technique should be planned from the beginning of surgery on older patients and be abandoned in favor of direct anastomosis only when a very adequate degree of elasticity of aorta is demonstrated.

A clamp with threaded mechanism is an important adjunct to the principle of hypotension for reduction of trauma. As opposed to clamps with ratchet lock, such a clamp may be applied as lightly as is consistent with complete occlusion and security from slipping. Inasmuch as rotation of the aorta by means of the clamp is undesirable in adults and unnecessary when a graft is used, the Southwick clamp with its handle at right angle to the jaws is satisfactory. Its use and mode of application is illustrated in Figure 1.

Arteriosclerotic aneurysms of the aorta in the high thoracic area are accompanied by a diffuse enlargement of the vessel above and below the lesion. This leads to a discrepancy in size between the caliber of the graft and the diameter of the transected end of aorta. Therefore, a double layer of suture seems to be indicated employing an inner everting mattress layer to facilitate in overcoming the discrepancy in caliber and an outer over-and-

Fig. 1.—Diagrammatic representation of position and size of aneurysm found in 23-year-old patient. The occluding clamp has been slowly closed to minimum degree producing complete block.



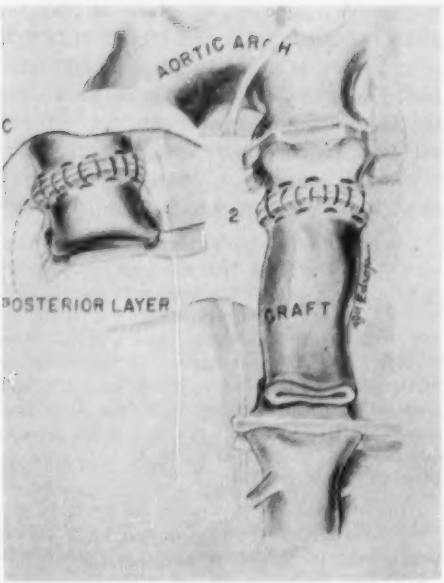


Fig. 2.—Proximal suture line completed following resection of aneurysm shown in Fig. 1. Insert shows position during placement of posterior row.

over suture to seal the everted edges. The application of these sutures is shown in Figure 2.

The employment of this same double row of sutures in cases of coarctation having no disproportion in size between graft and aorta is not nearly so important. However, inasmuch as there may be some delay in the healing of the suture line between homologous tissue and the recipient's artery, a double row would seem to provide a more secure anastomosis.

CLINICAL MATERIAL

The combined use of the two techniques, hypotension and hypothermia, has been made in nine patients undergoing coarctation resection requiring graft replacement and in two patients undergoing resection of the upper thoracic aorta for aneurysm. The aneurysms were situated immediately beneath the left subclavian branch of the aorta in each case, and, in one, arteriosclerotic changes in the left subclavian artery had resulted in its complete occlusion. The degree of acute deprivation to the distal part of the body was more severe in this case than in any of the others.

No evidence of ischemic damage to organs has developed in any of the 11 cases. No mortality has resulted in the group with coarctation, while one of the two patients having resection of a thoracic aneurysm died on the 12th postoperative day. Although the period of occlusion was 68 minutes, there was no evidence of spinal cord or visceral damage. This man had an uneventful course prior to this day, when, after a coughing spell, he died owing to hemorrhage. At the time of transection of the aorta between clamps, the tremendous degree of sclerotic change above and below the actual aneurysm was noted with dismay, and apprehension was felt concerning the stability of the anastomoses. They were completed without incident, however, and the resulting reconstruction appeared to be strong. At postmortem examination the source of the fatal hemorrhage was inconclusively determined to be distal to the graft, though a significant opening was not found.

The remaining successful case of aneurysm resection was in a much younger patient, and apparently his aneurysm was on a traumatic basis. Changes of a degenerative type were, however, also present above and below the lesion but in a much less severe form. Abstract of his history and course in brief is as follows.

J. L., a 22-year-old white man, had been in an auto accident in 1949. At that time he was treated for a left hemothorax which cleared under conservative management. Several months before his present admission a routine chest x-ray revealed a mass in the left lung field adjacent to the mediastinum. Pulsation of the mass was not seen on fluoroscopy. A left exploratory thoracotomy was performed on March 9, 1954, with a preoperative diagnosis of a mediastinal tumor. It was discovered that the lesion was an aneurysm. Because no graft was available for replacement of the lesion, the chest was closed. Recovery was uneventful. On June 30, 1954, when a homologous graft was available, the chest was again opened. The findings and the repair accomplished are illustrated in Figure 1 and 2. The aneurysm was mobilized and resected between clamps. The total complete aortic occlusion time was 30 minutes. The body temperature during this time was 82 F. Continuity of the aorta was reestablished with a preserved homologous graft. The patient's postoperative course was uneventful. No neurological changes were noted. The temperature, pulse, and blood pressure of this patient are shown in Figure 3.

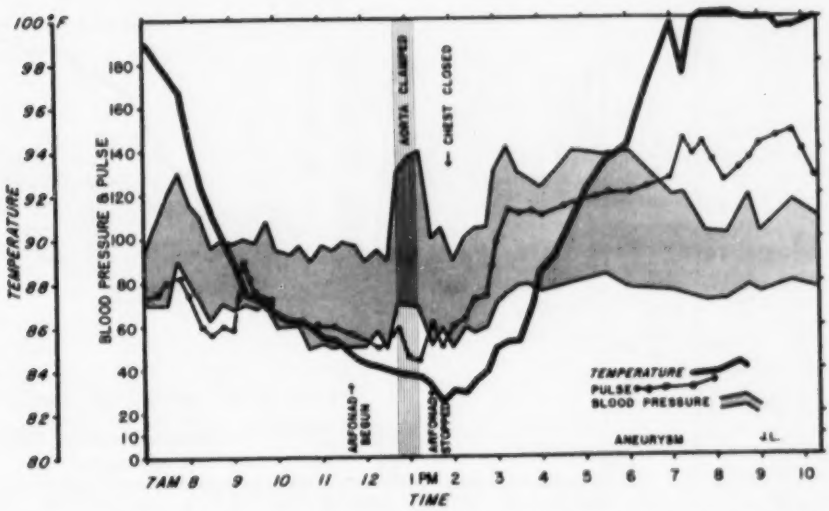


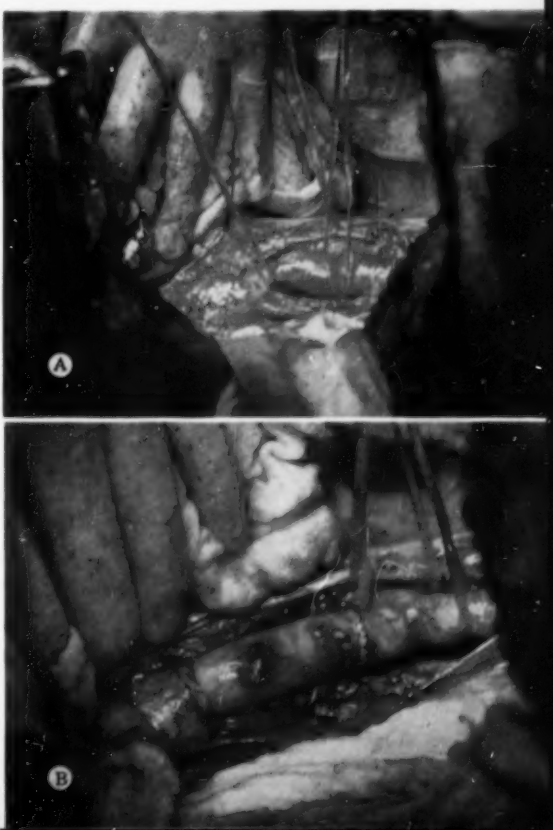
Fig. 3.—Temperature, pulse, and blood pressure record of J. L. during resection of thoracic aneurysm. Note slight rise in blood pressure during aortic clamping in spite of induced hypotension.

It has been mentioned that the refrigeration of the patient is aimed to produce a body temperature of 82-86 degrees F as measured by rectal thermometer. Early in this series some of the cases of coarctation did not reach this low level, as the effect of combining hypotension with hypothermia was rather cautiously explored.

An example of one of the instances of coarctation resection is as follows.

R. E., a 23-year-old white man, had known of an upper extremity hypertension for four years. On admission to the hospital the upper extremity pressure was 210/110. The femoral pulses were not palpable. A systolic murmur could be heard best over the chest posteriorly. Pulsations were palpable along the medial edge of the left scapula. The chest x-ray showed typical rib changes. A diagnosis of coarctation was made. On March 6, 1954, the coarctation was resected without difficulty. The defect was long, and direct repair would have required sacrifice of at least two sets of intercostal arteries. The area of the aorta just proximal to the area resected was moderately arteriosclerotic. Therefore, continuity was re-established with a preserved homologous artery graft (Fig. 4*A* and *B*). Except for a tachycardia which continued for several days

Fig. 4.—*A*, coarctation in R. E., aged 23, dissection completed. *B*, postoperative appearance with graft in place.



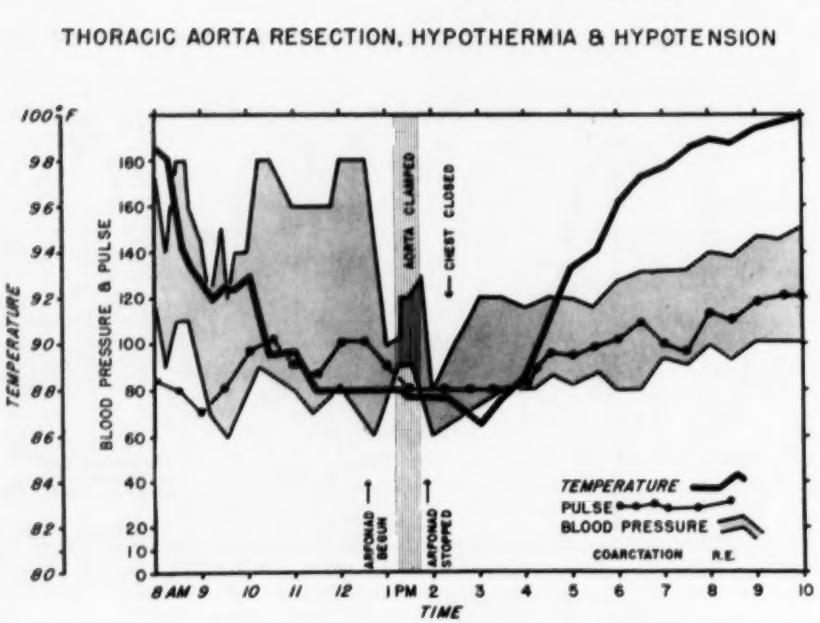


Fig. 5.—Temperature, pulse, and blood pressure record of R. E. during resection of coarctation.

postoperatively, the recovery was uneventful. The blood pressure, pulse, and temperature of this patient during surgery are shown in Figure 5.

The body temperature and blood pressure levels of all the cases just prior to clamp application are listed in the Table. The escape of the blood pressure control during aortic occlusion in the two patients with nonobstructing lesions (aneurysms) is also presented in this table.

Hypothermia and Hypotension in Thoracic Aortic Surgery

Patient	Age	Dose Chlorpromazine, Mg.	Min. Temp., F	Usual B. P. Min., Mm. Hg	Min. Pressure Obtained During Clamping
Thoracic aortic aneurysm					
J. L.	23	50	82	120/80	140/70
O. P.	51	50	82	160/100	160/80
Coaretation					
L. L.	23	0	98	220/120	140/80
J. O.	43	35	98	250/150	80/60
C. G.	23	30	86	220/130	100/80
N. H.	36	50	86	190/100	100/60
R. E.	23	40	86.5	200/120	160/60
R. K.	21	40	86	230/120	110/80
B. W.	21	36	86	190/110	100/80
E. S.	25	40	87	200/120	100/80
A. K.	20	95	90	160/90	100/60

COMMENT

Primary interest in these patients is concerned with the absence of damage to sensitive structures in the two patients undergoing aneurysm resection more than with its absence in the coarctation group. The absolute requirement of cooling in the human before high aortic occlusion is done as a planned procedure cannot be ignored in light of experimental evidence. Cross clamping of the aorta has, however, been tolerated without cooling. Accidental tear of the aorta during dissection of a patent ductus in a 23-year-old woman required 38 minutes of occlusion below the subclavian artery. This was followed by uneventful recovery without even fleeting neurological or urinary difficulty. Contrary to this experience of our own and similar instances reported by others is the definite occurrence of cord damage in thoracic aorta occlusion reported by Lam and Aram.[15] Variation in the completeness of longitudinal arterial continuity within the spinal canal is a possible explanation of these different results.

Another characteristic of hypothermia induced with chlorpromazine and cooling has been observed throughout this series. This concerns a distinct improvement in the early postoperative appearance and course of the patients.

SUMMARY AND CONCLUSIONS

Two patients underwent resection of the upper descending aorta for aneurysms immediately below the subclavian artery. In each case the preparation for high aortic occlusion was body cooling to 82 F. Occlusion times were 30 and 68 minutes. No ischemic damages resulted in abdominal viscera or spinal cord. One patient died on the 12th postoperative day of hemorrhage from rupture of the aorta distal to the resection.

Nine adult patients were cooled, six to a significant degree, in preparation for resection of coarctation. In all these patients the defect was closed with a preserved homologous graft. In each of the 11 patients the blood pressure was reduced to a marked extent before the occluding clamp was applied.

No untoward effects were noted from the combined use of hypotension and hypothermia.

REFERENCES

1. Morris, G.; Mayer, A. H.; Snyder, H. B., and Haynes, B. W.: Vascular Dynamics and Controlled Hypotension: A Study of Cerebral and Renal Hemodynamics and Blood Volume Changes, Ann. Surg. **138**:706, 1953.

2. Anlyan, W. G.; Shingleton, W. W.; Benson, W. R.; Stephen, R.; Salem, M., and Taylor, H. M.: A Study of Liver Damage Following Induced Hypotensive Surgery, Surgery **36**:375, 1954.

3. Glenn, W. W. L.; Hampton, L. J., and Goodyer, A. U. N.: Use of Controlled Hypotension in Large Blood Vessel Surgery, A. M. A. Arch. Surg. **68**:1, 1954.

4. Julian, O. C.; Grove, W. J.; Dye, W. S.; Olwin, J., and Sadove, M. S.: Direct Surgery of Arteriosclerosis, Ann. Surg. **138**:387, 1953.

5. Fay, T., and Henny, C. G.: Correlation of Body Segmental Temperature and Its Relation to the Location of Carcinomatous Metastases: Clinical Observations and Responses to Methods of Refrigeration, Surg., Gynec. & Obst. **66**:512, 1938.

6. McQuiston, W. O.: Anesthetic Problems in Cardiac Surgery in Children, Anesthesiology **10**: 590, 1949.

7. Bigelow, W. G.; Lindsey, W. K., and Greenwood, W. F.: Hypothermia: Its Possible Role in Cardiac Surgery; An Investigation of Factors Governing Survival in Dogs at Low Body Temperatures, Ann. Surg. **132**:849, 1950.

8. Laborit, H., and Huguenard, P. T.: L'Hibernation artificielle par moyens pharmacodynamiques et physiques en chirurgie, Presse méd. **59**:1329, 1951.

9. Bailey, C. P.; Cookson, B. A.; Downing, D. F., and Neptune, W. B.: Cardiac Surgery Under Hypothermia, J. Thoracic Surg. **27**:73, 1954.

10. Swan, H.; Seavin, I.; Blount, S. G., Jr., and Virtue, R. W.: Surgery Under Direct Viison in the Open Heart During Hypothermia, J. A. M. A. **153**:1081, 1954.

11. DeBakey, M. E., and Cooley, D. A.: Successful Resection of Aneurysm of Distal Aortic Arch and Replacement by Graft, J. A. M. A. **155**:1398, 1954.

12. DeBakey, M. E., and Cooley, D. A.: Successful Resection of Aneurysm of Thoracic Aorta and Replacement by Graft, J. A. M. A. **152**:673, 1953.

13. Beattie, E. J., Jr.; Nolan, J., and Howe, J. S.: Paralysis Following Surgical Correction of the Aorta, Surgery **33**:754, 1953.

14. Gross, R. E.; Bill, A. H., Jr., and Pierce, E. C., III: Methods for Preservation and Transplantations of Arterial Grafts: Observations on Arterial Grafts in Dogs: Report of Transplantations of Preserved Arterial Grafts in 9 Human Cases, Surg., Gynec. & Obst. **88**:689, 1949.

15. Lam, C. R., and Aram, H. H.: Resection of the Descending Thoracic Aorta for Aneurysms, Ann. Surg. **134**:743, 1951.

DISCUSSION

On Papers by Major Schafer, Lieut. Col. Hughes, and Capt. Barila and Drs. Julian, Grove, Dye, Sadove, Javid and Rose

Dr. John Lemuel Keeley, Chicago: Dr. McMillan, members, and guests: We have not had the opportunity of using the combination of hypothermia and hypotension, but I should like to show the course of the blood pressure in three adult cases of coarctation in which hypotensive drugs were used.

[Slide] Case 1: this patient, aged 31 years, a former Golden Gloves champion, had fought professionally, winning 19 out of 22 bouts. He was eventually disqualified beause of hypertension. His average systolic pressure was about 250 mg. Hg. He suffered a cerebral vascular accident and lost the sight of one eye owing to retinal hemorrhage about two years ago.

His blood pressure decreased somewhat with the preoperative medication and dropped further when he was placed on his side on the operating table. Before the aortic clamps were applied, camphor sulfonate (Arfonad) was given intravenously by slow drip. You can see the very prompt and marked fall in systolic blood pressure from 170 mm. Hg to approximately 100 mm. Hg.

Certainly the technical advantages that Dr. Julian has mentioned were very much appreciated in this patient. We were greatly concerned about anything that would raise his pressure during the course of the procedure, because of his history of cerebral vascular accident.

He made a completely uneventful recovery. His pugilistic training may have raised his pain threshold, because he did not receive any medication postoperatively for pain. He was an ideal patient and made a perfectly fine recovery. His current blood pressure readings are now about 150/90.

[Slide] Case 2: all these patients seemed to be quite husky. This man, aged 21 years, weighed about 190 lb. His systolic pressure was running much over 200, and here we had a somewhat more difficult situation in resecting his coarctation. It was necessary to clamp his aorta proximal to the subclavian artery. For some reason or other he did not respond to the camphor sulfonate.

As Dr. Julian has indicated, perhaps it was the blocking off of additional collaterals that may have interfered with the action of the drug. It was a rather long procedure, and during the course of this operation he developed edema of the dependent lung, which worried us for awhile, but that cleared after a few hours and he made a very satisfactory recovery.

[Slide] Case 3: the third patient (and these have been consecutive ones in adults) was given a combination of a brand of chlorpromazine hydrochloride (Thorazine), a drug potentiator, and camphor sulfonate very early during the course of his operation. His systolic blood pressure was maintained at approximately 100 mm. Hg throughout the entire procedure, as you see here.

The placing of the clamps made very little difference in his blood pressure levels. He likewise made a very satisfactory recovery, and he seemed to have no ill effect from the combination of drugs used.

I should like to ask Dr. Julian two questions: first, whether or not he believes that hypothermia and hypotension should be used routinely in all adult cases of coarctation; second, whether or not the pressure should be dropped during the dissection of the chest wall, where so many collaterals are encountered. The possibility of the blood pressure coming up later and causing concealed hemorrhage after the chest is closed is the consideration that has prompted this second question.

DR. HENRY SWAN II, Denver: Dr. McMillan and gentlemen, I would like to compliment Dr. Schafer and his group on the extremely interesting study which they have presented tonight. I think it is a terribly important type of work, because it is important to study the lower ranges of hypothermia.

If I interpreted their slides correctly, I believe Dr. Schafer was talking primarily about the range between 13 and 20 degrees. Secondly, I think it is very important to study the problem of ventricular fibrillation, since at the present time, as he indicated, this is certainly a little understood and very controversial matter.

I know he does not wish to have these results given a broad interpretation at this time, because he is studying an area of hypothermia about which not much is yet known and because he was using adult and healthy animals.

We have been confused about the subject of ventricular fibrillation in our laboratory and have spent a great deal of time in an effort to prevent it. We have had no experience in the temperature ranges below 20. Between 22 and 28 roughly, as he indicated in his slides, ventricular fibrillation occurs with distressing frequency in both animals and humans.

We have attempted to prevent that by the use of hyperventilation and, more recently, by the use of anticholesterinase agents such as neostigmine, and these two methods have been fairly effective. We also have found that potassium chloride is of help in defibrillation of the cold dog and of the cold human. Potassium chloride is usually not necessary or indicated in the warm individual.

In spite of these efforts to prevent it and to treat it, we have had the feeling that ventricular fibrillation in the cold individual, who does not have perfusion of the heart and in whom therefore the myocardium is hypoxic (and we must remember that there is a great deal of difference in experiments in which the myocardium is being perfused and those in which it is not), is harmful to the patient. We have only a little experimental evidence in that regard.

[Slide] Here is a little bit of it. This is in warm animals, as a matter of fact. This is the level of potassium in the coronary sinus blood before fibrillation, while the heart is beating regularly and normally, and then during fibrillation. One can see that although these are not true balance studies, nonetheless the concentration of potassium in the blood recovered from the myocardium shows a tremendous increase during the state of fibrillation.

[Slide] In the application of hypothermia clinically we have had some considerable problems, of course, and here is a very thumbnail recent sketch of the status of our series of 75 patients with various diseases undergoing various applications of hypothermia.

We have had 13 patients whose deaths we thought might be related to the technique in one way or another. As we analyzed those 13 deaths we found that 8 of them were primarily cardiac arrhythmias which we could not reverse and in which we were unsuccessful in restoring a sustained normal beat. Five of them died of what we called cardiac failure in the immediate postoperative period—hearts which dilated and which were unable to sustain the circulation.

Of the five patients dying of cardiac failure, three had fibrillated during the procedure and had been resuscitated to a normal rhythm, but later they failed. Therefore, at least in our experience, in the range between 22 and 32, the myocardium still is the limiting factor in the clinical application of hypothermia.

We have had no central nervous system difficulty, although we have not had prolonged cessation of circulation such as was described in these experiments, that is, cessation of circulation associated with fibrillation up to one or two hours, as Dr. Schafer has described.

Therefore, I believe that one must be cautious in the interpretation of this type of data. Certainly the sick human heart is not the same as the well dog heart, and I know that he would agree that we should not make any sweeping interpretation until a lot more information has been obtained on this very perplexing problem of the significance of ventricular fibrillation.

Major Paul W. Schafer, Washington, D. C.: I should like to avail myself of the privilege of discussing Dr. Julian's paper and Dr. Keeley's remarks. The work they have presented is certainly most instructive and very important. I can add only a little bit which I think may perhaps amplify a few of the remarks they have made.

In 1947, somewhat ill-advisedly and with youthful enthusiasm—rashness I suppose would be a better term to apply to it—we undertook the repair of a coarctation in a 67-year-old man. It was at the time when Dr. Crayford had demonstrated the feasibility of repairing coarctation. No one was at all recommending that it be undertaken in patients of this age, but we attempted it.

We exposed the field, and I have never seen such a technically difficult operative field as we encountered. Here was this huge, tensely distended, pulsing, and sclerotic aorta, which no clamp I had available would have been able to hold. Fortunately for the patient, we recognized that we had a completely impossible situation from the technical standpoint, and we terminated the operative procedure, and the man had no untoward difficulty with the operation.

Therefore, this spring, when a 54-year-old woman came to me, also with a coarctation, with a systolic blood pressure which we could not measure on our standard clinical manometers, with a history of having had one severe coronary and many small encephalopathies, if not one frank stroke, I was not too optimistic about undertaking the resection and repair of her coarctation. She, too, was sclerotic. But after an understanding with the family and with the patient, we elected to attempt it, because we thought that hypothermia might change this difficult technical field into one of relative simplicity. And so it was.

We used none of the hypotensive drugs; nor did we use chemical agents in relation to her hypothermia. She was cooled into essentially the same range as presented here, with only the use of crushed ice and the mattress. Her temperature came down to just 80. Her blood pressure during operation, during the time of cross clamping, was 100/70. Her pulse rate varied between 70 and 80. We could not have had a more simple take-down resection of the coarctation and end-to-end anastomosis.

The patient had no postoperative difficulties. She has been seen at monthly intervals since, and now has a pressure of 120/70. I would use her as a basis for strongly reinforcing the recommendation that Dr. Julian and Dr. Keeley have made, namely, that by changing this situation of severe hypertension into one of normal tension or hypotension interruption in the great vessels becomes technically an extremely simple problem.

Dr. Ormand C. Julian, Chicago: I would like to ask Dr. Schafer a question: During fibrillation do we know actually how much central circulation there is going on, that is, coronary circulation, and how much peripheral circulation, particularly of the brain and spinal cord, from this ineffective (or at least we suppose ineffective) kind of ventricular action?

Major Paul W. Schafer, Washington, D. C.: I should like to thank Dr. Swan and Dr. Julian for their discussion of the paper, and I should like to make my first comments referable to Dr. Swan's discussion.

I tried to make it very clear, as he indicated that he understood its clarity (and I hope the rest of you have also), that we did not want any part of this report to be the basis for any rash clinical application. This is of course an experiment that has been carried out with normal adult dogs.

Furthermore, we did not attempt accurately to simulate circumstances that would be encountered in terms of application of this technique in clinical surgery, because these animals were simply allowed to fibrillate and then were left undisturbed.

We were simply trying to create a control experience to which we could relate our current and our projected researches, all of which bear on the implied questions and the actual questions that were asked.

For instance, we have now 40 animals that have had just about every conceivable kind of cardiac and cardiovascular derangement created, and they will be studied in duplicate fashion with this control series.

We also have a series now under way in which there has been added to the experiment a total cross clamping of the heart from the systemic and pulmonary circulation, and those results will be reported on later.

Without going into further detail, there are several additional study groups which we propose to establish. We can say at this time only that these are the experiences we have had with normal adult dogs under these conditions, and we hope that we will be able to report later this year a follow-up with some of these other experimental groups.

As to Dr. Julian's question, I can't answer it. There is a great deal of experimental work that has been done in an attempt to determine the actual existence of a minute volume flow of blood in different parts of the systemic, pulmonary, and visceral circulations during several states of marked derangement of cardiac action. Ventricular fibrillations have been classified. One just cannot say how much actual central or even peripheral blood flow occurs in these animals under these conditions. I am sure, from my own observation, that some flow does occur.

As we have worked with the animals, it is almost unbelievable that there would not be some motion of blood during the early stages of a rather active fibrillation. It is a strange thing, however, that after you get out to one, one and a half, or two hours of fibrillation, you can be pretty sure, even though it is difficult to measure, that there is no flow. These animals stop fibrillating in this area and go into cardiac arrest, as I mentioned.

As you open the chest the nearest thing I can relate it to is a quarter of beef hanging in a refrigerator. They are cold; they are still; their fat is solidified, and it is much like beef suet. I don't believe there is any flow at that stage, but early I am sure there is flow, and it may be a substantial amount.

DR. ORMAND C. JULIAN, Chicago: I want to thank Dr. Keeley and Dr. Schafer for their discussion.

We would consider that hypotension and hypothermia should be used in adult cases of coarctation on the basis of one additional consideration. Certainly in each case of an adult coarctation we do want hypotension. I think that having worked with it in these cases and in some others that were not reduced in temperature, we would find it inconvenient to operate on these patients without reducing their blood pressure. When you reduce the blood pressure in the upper extremities to levels of 100 systolic in a patient who is depending upon a collateral bed to supply his distal body, the collateral bed becomes less efficient, and all of the elements of cross clamping of the aorta are in some degree represented in these patients with reduced pressure on their collateral bed. Therefore, they need hypothermia.

The second question was, shall we drop the blood pressure throughout the operation, or only when the aorta is cross clamped? We haven't produced hypotension other than during the clamping of the aorta. We feel that, although the opening of the chest in a coarctation patient might be made easier by hypotension, there is the element of the danger of bleeding, as Dr. Keeley mentioned. Also, any drug that is as effective and active as camphor sulfonate might well be used in our patients for as short a time as possible, to prevent any undesirable side-reactions.

Risk of Surgery in Patients with Myocardial Infarction

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The progressively increasing age of the population has been accompanied by an ever increasing incidence of degenerative heart disease. The problem of operating upon a patient whose surgical condition is complicated by a cardiac lesion confronts the surgeon today more and more frequently.

In large numbers of patients with heart disease the need for surgery is imperative. Operative intervention is life-saving in such emergencies as acute appendicitis, perforated viscus, or strangulated hernia. In most types of cancer, surgery is the only means or the best means of prolonging life or affording the possibility of cure. Surgical treatment is also mandatory in conditions such as prostatic obstruction or common-duct stone with which the cardiac patient may be afflicted. Although not necessarily life-saving, surgery certainly may be strongly indicated in other chronic or disabling states, including some hernias, peripheral vascular disease, and peptic ulcer with pyloric obstruction. In spite of the obvious need, many patients are denied surgery today because their cardiac status "makes the risk too great." In some cases it is the surgeon who is unwilling to accept the responsibility of operating on the cardiac patient. At other times the internist may strongly advise against surgery and condemn the patient to continued suffering and perhaps death. The patient himself, or his relatives, indocrinated with the danger of sudden death from cardiac causes, may refuse a procedure which is strongly recommended.

Although much has been written regarding the evaluation and surgical management of the cardiac patient, there are few statistical studies which define the actual risk in operating upon the subject with degenerative heart disease. The available reports,* particularly the more recent ones, suggest that the risk is not so great as had been imagined. Several of the authors conclude that the risk may be only slightly greater than that incurred in operating on a group of patients in a comparable age group without heart disease. Table 1 lists statistical studies of surgery in cardiac patients appearing during the past three decades. Noteworthy is the report by Hannigan and co-workers [6] on prolonged and extensive cancer operations upon patients with healed myocardial infarcts. The operative mortality for 58 such procedures was 5.2%.

The present study was undertaken to further determine the risk of surgery in the cardiac patient. Subjects with myocardial infarction were chosen for investigation rather than a larger group with the general diagnosis of arteriosclerotic heart disease. The varying degrees of involvement and the difficulties in accurate classification of the latter would tend to detract from the significance of the results. Although myocardial infarc-

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Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Col., Dec. 2, 1954.

* References 1 to 6.

tions also may vary in extent and severity, it was felt that this condition represented an unmistakable diagnosis of, and definite landmark in, the course of coronary artery disease.

METHODS OF STUDY

Records of the Surgical Service at the Portland Veterans Hospital were searched for patients with myocardial infarcts who had undergone surgery. For the purposes of this study, only those with definite electrocardiographic evidence of recent or old infarcts were selected. A number of other patients with quite definite histories of coronary occlusion but with normal or equivocal electrocardiograms were excluded. Between the years 1947 and 1954 a total of 70 patients were found who had definite evidence of myocardial infarction prior to surgery. Of this group, 50 patients were hospitalized at this institution for their acute coronary occlusion. Clinical records of these previous admissions contained unmistakable evidence of infarction, and electrocardiograms repeated prior to surgery were confirmatory. Twelve patients with a history of being hospitalized elsewhere or confined at home for an acute attack had electrocardiograms indicative of previous infarction. The remaining eight patients gave no history to suggest myocardial infarction, but the electrocardiographic evidence was definite, and they were included in the study as "silent coronaries." One attack of coronary occlusion had occurred in 57 of the patients; 13 had two previous episodes of infarction.

The clinical records of the group of 70 patients were studied for an evaluation of their cardiac status including evidence of hypertension, congestive failure, and cardiac arrhythmias. Information was assembled from the operative records of each patient with reference to preoperative preparation, anesthetic agent, type and duration of operation, operative shock, and the amount of blood and parenteral fluid administered. The postoperative course of each patient was investigated and complications and deaths listed. An effort was made to correlate the incidence of deaths and complications with the severity of the heart disease and the surgical management of the patient.

RESULTS

The 70 patients studied were subjected to 111 operative procedures, as listed in Table 2. Of the operations performed, 72 could be classified as "major operations" and 39 as "minor." One or more major procedures were performed on 50 patients, while 20 had one or more minor and no major operations. In every instance but one, it might be noted, the surgeon in charge of the case was aware of the patient's cardiac status and proceeded with the operation because of clear-cut indications which he felt outweighed the anesthetic and operative risk.

There were four operative deaths in the series under study. This amounts to an operative mortality of 5.7% of the 70 patients. Since the same risk is incurred with each operative procedure, however, a more correct expression of the mortality rate would be 3.6% of the 111 operations. Postmortem examinations were performed on each of the four patients who died. Three of the deaths were due to acute coronary occlusions which occurred during the postoperative period. The fourth death was attributed to massive gastrointestinal hemorrhage from a chronic

TABLE 1.—*Reports on Risk of Surgery in Patients with Degenerative Heart Disease*

Author and Year	Cardiac Lesions Studied	Patients, No.	Operations, No.	Deaths	Operative Mortality,* %
Sprague,[1] 1929	Heart disease, all types	170	192	42	21.8
	Arteriosclerotic heart disease	75	...	24	32
Butler & Feeney,[2] 1930	Heart disease, all types	414	494	60	12.1
	Previous infarcts	8	8	1	12.5
	Acute infarcts	5	5	4	80
Hickman, et al.,[3] 1935	Healed infarcts	8	13	1	7.7
Brumm & Willius,[4] 1939	Coronary artery disease (incl. 32 healed infarcts)	257	257	11†	4.3
Morrison,[5] 1948	Arteriosclerotic heart disease (incl. infarcts)	311	485	46	9.5
	Previous infarcts	25	37	3	8.1
Hannigan, et al.,[6] 1951	Healed infarcts	58	58	3	5.2
Baker, Grismer, & Wise, 1954	Acute and healed infarcts	70	111	4	3.6

* Mortality calculated on basis of total operative procedures.
† Deaths from cardiac causes; total operative mortality not reported.

TABLE 2.—*Operations Performed upon 70 Patients with Previous Myocardial Infarcts*

Enucleation of eye	1	Drainage ischiorectal abscess	2
Cataract extraction	8	Anal fistulectomy	1
Hemilaryngectomy	1	Cystostomy	1
Subtotal thyroidectomy	2	Nephrostomy	1
Total thyroidectomy	1	Cutaneous ureterostomy	2
Resection mandible, tongue, lip, neck dissection	1	Suprapubic prostatectomy	4
Simple mastectomy	2	Transurethral resection of prostate	11
Segmental resection of lung	1	Perineal exploration and biopsy of prostate	1
Excision tumor of abdominal wall	1	Saphenous vein ligation	3
Secondary closure abdominal wound	1	Excision prepatellar bursa	1
Inguinal herniorrhaphy	1	Sequestrectomy, femur	1
Lumbar sympathectomy	2	Midthigh amputation	1
Exploratory laparotomy	1	Hip disarticulation	1
Subtotal gastrectomy	1	Intramedullary fixation, femur	2
Gastrostomy	1	Local excision skin cancers	27
Cholecystectomy	1	Plastic repair eyelid	1
Cholecystectomy, choledochostomy	1	Repair perforated iris	1
Embolectomy, sup. mesenteric artery, bowel resection	1	Plastic repair of lip	1
Appendectomy	3	Excision cancer of lip	1
Right colectomy	2	Nasal polypectomy	2
Segmental resection colon	1	Skin graft	2
Abdominoperineal resection of rectum	2	Vasectomy	1
Revision of colostomy	1	Urethral meatotomy	1
Repair rectal prolapse	1	Muscle biopsy	1
Hemorrhoidectomy	1	Excision axillary nodes	1

duodenal ulcer which occurred 19 days following a hip disarticulation. Postmortem study of the heart in each of the patients revealed evidence of old myocardial infarction, as well as the acute infarcts in three instances. The significant data relating to the operative deaths are summarized in Table 3.

Case No. 4 of the operative deaths is related in more detail since it illustrates the difficulty encountered in predicting the operative risk and in ascribing the outcome to the extent of surgery performed.

The patient, a 59-year-old white man, had been treated at this and other institutions since 1951 for an extensive carcinoma of the lower lip. He was admitted to this hospital in February, 1953, with severe precordial pain and with signs of congestive heart failure; electrocardiograms revealed an acute posterior wall myocardial infarction. Serial electrocardiograms during his two-month hospitalization indicated healing and stabilizing of the lesion. The patient was readmitted on July 21, 1953, in mild congestive failure and with a massive recurrence of the lip cancer with involvement of the mandible, tongue, floor of mouth, and cervical lymph nodes. Following digitalization and preoperative preparation, the patient underwent a major head and neck operation on Aug. 3, 1953, which involved excision of the lip, tongue, and mandible, and block dissection of the neck. The procedure lasted over four hours; there was considerable blood loss, necessitating a transfusion of 3 pt. of blood. Despite the magnitude of the surgery, the patient made a speedy and uneventful recovery with no cardiac complications. On Sept. 1, 1953, a relatively minor plastic operation was performed for repair of the lower lip. The patient recovered from this procedure seemingly without difficulty, but on his fifth postoperative day died suddenly while in the bathroom. Postmortem examination revealed an acute coronary occlusion. This case, of course, is listed as an opera-

TABLE 3.—*Operative Deaths*

Case No.	Age	Time Interval Infarction-Surgery, Mo.	Operation	Anesthesia	Duration, Surgery, Min.	Day of Death (Postop.)	Cause of Death
1	79	30 & 36	Hip disarticulation	Spinal	70	19	Massive G. I. hemorrhage from chronic duodenal ulcer
2	61	3	Resection sigmoid colon	General	180	2	Acute myocardial infarction
3	63	13	Simple mastectomy	Local	35	14	Acute myocardial infarction
4	59	7	Plastic repair of lip	General	45	5	Acute myocardial infarction

tive death, but it is difficult to decide whether the patient's sudden death should be ascribed directly to his recent minor surgery or to the ever-present possibility of a repeated attack that threatens every patient who has had a coronary occlusion.

There were 20 complications following the 111 operations performed. Twelve of the complications were familiar postoperative sequelae which may occur after the procedures listed, while eight may be classified as cardiorespiratory complications. The latter are of far more significance in patients with prior myocardial infarction. Table 4 lists the postoperative complications encountered and their outcome.

TABLE 4.—*Operative Complications*

	No.	Outcome
A. Cardiorespiratory:		
Postoperative hypotension	4	Recovered
Pneumonia	1	Recovered
Acute coronary occlusion	3	Died
	8	
B. Other complications:		
Wound infection	3	Recovered
Wound disruption	1	Recovered
Urinary tract infection	2	Recovered
Epididymitis	1	Recovered
Thrombophlebitis	1	Recovered
Ileus	1	Recovered
Cerebral vascular accident	1	Recovered
Necrosis of colostomy—revised	1	Recovered
Massive hemorrhage from chronic duodenal ulcer	1	Died
	12	

An analysis of the complications and deaths with reference to the patient's cardiac status is revealing. There were 23 patients with a diagnosis of hypertensive cardiovascular disease as well as myocardial infarction. Of these, 3, or 13%, developed cardiorespiratory complications or died, while 20 had an uncomplicated postoperative course. Of the 47 nonhypertensive patients, 12.8% developed complications or died. Thus, in accord with the experience of others, the presence of hypertension did not add materially to the operative risk.

Congestive heart failure had appeared at some time prior to surgery in 13 patients. Cardiorespiratory complications or death occurred in 5 or 38% of this group, and in only 7% of the patients who had never exhibited signs of decompensation. Congestive failure, indicating inability of the heart to carry out its normal function before the added strain of surgery, thus seems to add significantly to the operative risk.

Abnormalities in rhythm have been listed as a potentially dangerous sign in the preoperative evaluation of a cardiac patient. Cardiac arrhythmias of one type or another were present in 17 of the patients studied. Cardiorespiratory complications or death occurred in 4, or 23.5%. In the 53 patients with normal rhythm there were 9.4% cardiorespiratory complications or deaths. There was no discernible relation between heart size and the incidence of complications or deaths in this series, nor did a history of angina pectoris seem to be of significance. The information concerning the preoperative cardiac status and the outcome of surgery is graphically depicted in Figure 1.

As might be expected, the majority of the patients were of an advanced age. The average age of the group was 61 years; the youngest patient was 37, and the oldest 86. The age of the patient in this series had no effect on the outcome of surgery. Cardiorespiratory complications occurred in two patients in the fifth decade of life, four in the sixth decade and two in the seventh.

The surgical management of the patients in this series had a definite effect on the outcome; however, some factors did not exercise the influence that might be predicted. The morbidity and mortality varied only slightly with the magnitude of the operative procedure. There were six (8.3%) cardiorespiratory complications or deaths after major operations, compared to three (7.7%) after procedures listed as minor. The greater number of these complications and deaths also accompanied procedures which consumed more than one hour's operating time (Fig. 2).

Since the diagnosis of myocardial infarction was known in this group of patients, it was elected to use local infiltration or re-

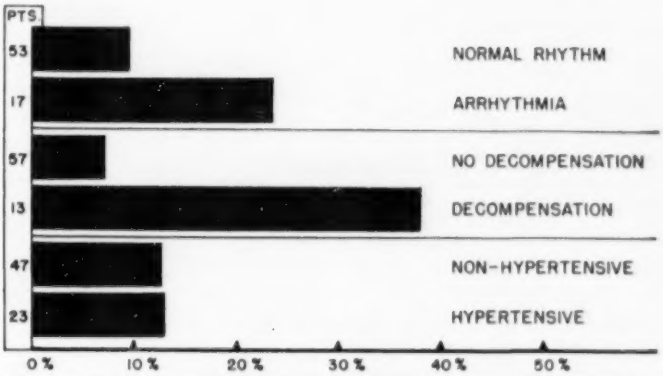

FIG. 1 PER CENT CARDIORESPIRATORY COMPLICATIONS AND DEATHS IN RELATION TO PRESENCE OF HYPERTENSION, CARDIAC DECOMPENSATION, AND ARRHYTHMIAS.

Figure 1.

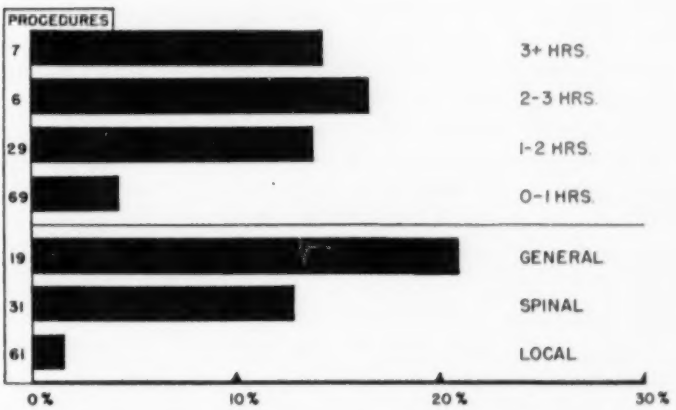

FIG. 2 PER CENT CARDIORESPIRATORY COMPLICATIONS AND DEATHS IN RELATION TO LENGTH OF OPERATION AND TYPE OF ANESTHESIA.

Figure 2.

gional block anesthesia for many of the operations. Of 61 procedures carried out with this type of anesthesia there were no complications and but one death (Case No. 3). Nineteen patients were given a general anesthetic; this usually consisted in thiopental (Pentothal) induction followed by cyclopropane or ether and oxygen. There were four (21%) cardiorespiratory complications and two deaths in this group. The remaining 31 patients were operated upon under spinal anesthesia, with a complication and death rate of 4, or 12.9% (Fig. 2).

No relation was noted between the morbidity or mortality rate and the occurrence of hypotension during the operative procedure. In only four patients did the blood pressure fall to shock levels during surgery; no complications ensued. Study of the records failed to reveal any increase in complications in patients who received multiple blood transfusions or large volumes of parenteral fluid during surgery or in the postoperative period.

There is little information in the literature on the results of surgery performed during the acute or the healing stages of myocardial

TABLE 5.—*Results of Surgery Performed During the Acute Stage of Myocardial Infarction*

Age	Time Interval Infarct-Surgery (Days)	Operation	Anesthesia	Duration of Surgery, Min.	Complications
58	1	Exploratory laparotomy (acute pancreatitis)	Spinal	100	None
65	7	Embolectomy, superior mesenteric artery; small bowel resection	Spinal	300	None
60	14	Appendectomy	Spinal	65	None
43	21	Excision skin cancer (melanoma)	Local	70	None
70	27	2d stage suprapubic prostatectomy	Spinal	65	None

infarction. Butler and Feeney [2] relate that among five patients operated upon during the acute attack there were four deaths; Sprague [1] reports one death on the operating table of a patient with an acute coronary occlusion. The clinical and pathological study by Mallory and co-workers [7] has indicated that the myocardium is weakest within the first 10 days following infarction. Healing of small infarcts is complete within one month while larger infarcts may take up to two months to heal completely. In view of these studies it is generally advised that whenever possible surgery should be deferred for at least six weeks following the attack. However, an urgent surgical condition will occasionally present itself at the time of, or shortly after, infarction. The surgeon is then confronted with the problem of operative intervention before healing of the myocardial lesion has occurred. There is a real need for the publication of the experiences of other groups to aid and guide the surgeon when he is faced with this dilemma.

In this series, five operations were performed within 30 days of the onset of an acute myocardial infarct. In one case an exploratory laparotomy was performed on the day following the acute cardiac episode. Signs of an upper abdominal catastrophe accompanied the clinical evidence of coronary occlusion. Serum amylase determinations were equivocal; exploration revealed an acute edematous pancreatitis. The patient's recovery was uneventful. It is of interest that no deaths occurred among the five patients operated upon soon after infarction, nor did any operative complications appear. Details of the five procedures are presented in Table 5.

TABLE 6.—*Results of Surgery Performed Thirty to Ninety Days After Myocardial Infarction*

Age	Time Interval Infarct-Surgery, Days	Operation	Anesthesia	Duration of Surgery, Min.	Complications
59	32	Excision skin cancer	Local	10	None
62	41	Excision prepatellar bursa	Spinal	25	None
54	42	Thyroidectomy	General	155	Transient hypotension following surgery; recovered
56	53	Right colectomy	Spinal	120	Wound disruption, treated by packing; recovered
54	56	Plastic repair ectropion	Local	50	None
62	58	Intramedullary rod fixation, fracture of femur	Spinal	60	None
56	60	Muscle biopsy	Local	10	None
57	60	Excision skin cancer	Local	15	None
55	60	Retropubic prostatectomy	Spinal	120	None
58	66	Excision skin cancer	Local	35	None
55	70	Excision axillary lymph nodes	Local	75	None

Eleven additional patients were subjected to surgical procedures within one to three months following acute myocardial infarction (Table 6). Although healing of the cardiac lesion may have occurred after a month's lapse, one might still expect surgery during this early stage to be hazardous. There were no operative deaths in this additional group of patients. Two complications ensued, an abdominal wound disruption and an episode of postoperative hypotension. Both patients recovered.

Follow-up data are incomplete on the entire 70 patients in this series. Six patients are known to have died of their cardiac disease, two within 6 months of surgery, two within 1 year, and two within 18 months. Eight additional patients have died of other causes: four with cerebral vascular accidents, three with cancer, and one of unknown cause.

COMMENT

Studies of the natural history of coronary artery disease have emphasized its unpredictable course and the frequency of full functional recovery in patients who have had myocardial infarction. In recent years there has been increasing optimism regarding the prognosis in patients who recover from the acute attack. In the consecutive series of 100 patients followed by Smith,[8] there were 66 survivors after 10 years and 16 patients known to be alive 20 years after myocardial infarction. The reports of Master and Dack,[9] Levin and Rosenbaum,[10] and Boas [11] all emphasize the possibility of long periods of survival and of return to full or partial occupational activity. In view of this it seems to us that the argument to withhold indicated surgery because of the cardiac patient's limited prognosis for survival is no longer valid. There remains the immediate risk of anesthesia and surgery, which we have attempted to evaluate in this study.

The outcome in this series—the recovery of 66 of 70 patients from 111 operations—is not fortuitous. Successful management of the cardiac patient subjected to surgery depends on collaboration of the internist, the surgeon, and the anesthesiologist. Each plays an important and indispensable part in the evaluation and treatment of the patient. The internist can inform members of the team of the severity of the cardiac lesion and the functional capacity of the patient's heart. He can aid in preoperative management not only by treatment of decompensation and arrhythmias but by reassuring the patient as to the safety of anesthesia and the proposed surgery. The surgeon alone can best predict the load which surgery in his hands will put on the patient's heart; he is most familiar with the time the procedure will consume, the probable blood loss, and the possibility of shock and of postoperative complications which may ensue. The successful performance of surgery depends also on the ability of the anesthesiologist. Skillful induction, avoidance of anoxia, and careful replacement of blood and fluids during surgery contribute much toward uneventful recovery.

Much remains to be learned of the actual strain which anesthesia and an operative procedure places upon the heart. In patients who have recovered from their infarction and returned to their occupation this strain may be negligible. It is possible that in certain uncomplicated operations there may be no more cardiac load than when the patient is asleep. On the other hand, rough anesthesia with anoxia and excessive blood loss with hypotension may precipitate cardiac failure or further myocardial infarction. It is also probable that undue emotional stress and the occurrence of postoperative complications may contribute as much to an unsuccessful outcome as the surgery itself.

We have not presented this study to advocate wholesale or indiscriminate surgery on patients with degenerative heart disease. These patients do present a definite operative hazard and surgery is warranted only as a calculated risk in the presence of definite indications. It is emphasized, however, that with careful management the majority of these patients will tolerate surgical intervention, and urgently needed operative procedures should not be denied them.

SUMMARY AND CONCLUSIONS

Seventy patients with previous myocardial infarcts were subjected to 111 operative procedures.

The operative mortality rate was 3.6%. There was an incidence of 7.2% cardiorespiratory complications.

The incidence of deaths and complications was higher in patients with a history of congestive failure and in those with cardiac arrhythmias. There was no apparent relation to angina pectoris, an enlarged heart, or hypertension.

The incidence of complications and deaths was greater in longer operative procedures and in those in which a general or a spinal anesthetic was used rather than a local one.

Five patients were operated upon within 30 days of an acute mycoardial infarction; there were no operative complications or deaths. Eleven patients were operated upon within 30 to 90 days of the acute attack; there were two complications and no deaths.

While evidence of myocardial infarction may increase the operative risk, it is not a contraindication per se to an operation which is urgently needed. Close collaboration between the internist, the surgeon, and the anesthesiologist will contribute toward a successful outcome.

Dr. Zolton T. Wirtschafter, Chief of the Medical Service, and Dr. Leonard W. Ritzman, Chief of the Cardiology Section, gave their advice on this study.

DISCUSSION

DR. CARL B. DAVIS, JR., Chicago: I know that many of you share with me the thought that this paper was an excellent presentation of the subject.

About two years ago, at the meeting of the Central Surgical Association, dePeyster, Paul, and Gilchrist, of the Presbyterian Hospital, in Chicago, discussed the urgent need for surgery in patients who had recent or old myocardial infarctions and discussed the risk involved in these cases.

I should like to cite to you one personal experience involving a 60-year-old man who had been treated for rectal polyps by fulguration by an out-of-town doctor. When he was admitted to our hospital, we found that he had a carcinoma of the rectum. We prepared him for a combined abdominal-perineal resection. He had given no history of any previous cardiac distress or complaints. As a result, no electrocardiogram was taken preoperatively.

During the course of the operative procedure, after the superior hemorrhoidal artery had been divided and after division of the rectosigmoid colon, the proximal end of the distal stump was tied off with a rubber tampon and placed down in the pelvis as one normally does in this procedure. About this time, when we were closing the pelvic peritoneum, it appeared that the small bowel was very lax and had no tone. We spoke to the anesthetist about the condition of the small bowel, which then became dusky, and suggested that there was something wrong with the cardiorespiratory system.

During this procedure the patient had been receiving thiopental (Pentothal) sodium anesthesia not only to induce anesthesia but as an aid to general anesthesia. As it happened, the man had an acute myocardial infarction on the operating table. We did not feel it safe to go ahead with the second stage procedure.

Approximately 7 to 10 days later, late on a Sunday evening, his temperature went to 105 F. During those days, even though decompression of the distal stump had been carried out by the use of a catheter placed in the anus, it was our feeling that this man probably had developed a perforation. A very rapid second-stage procedure of a combined abdominal-perineal resection was done, using procaine hydrochloride (Novocain) and nitrous oxide anesthesia. We realized full well the risk of returning the patient to the operating room.

We found a very foul-smelling abscess with a perforation of the proximal end of the distal stump near the point where we had ligated the colon in using the rubber tampon. The patient was treated with massive doses of antibiotics. His myocardial situation was cared for by the medical service, and one week later he had another massive fatal myocardial infarction of the left ventricle, which was demonstrated at autopsy.

We felt that this patient had received perhaps too much thiopental sodium with a resultant drop in blood pressure which led to the development of the coronary occlusion. We hope that thiopental sodium will be used more as an agent of induction of anesthesia rather than as a routine supplement of general anesthesia. I hope, also, that none of you will ever have a similar experience.

I wish to commend Dr. Baker for his excellent presentation, which was so well illustrated with beautiful slides.

REFERENCES

1. Sprague, H. B.: The Heart in Surgery, Surg., Gynec. & Obst. **49**:54-58 (July) 1929.

2. Butler, S., and Feeney, N.: The Patient with Heart Disease as a Surgical Risk, J. A. M. A. **95**: 85-91 (July 12) 1930.

3. Hickman, J.; Livingstone, H., and Davies, M. E.: Surgical and Anesthetic Risk in Heart Disease, Arch. Surg. **31**:917-936 (Dec.) 1935.

4. Brumm, H. J., and Willius, F. A.: Surgical Risk in Patients with Coronary Disease, J. A. M. A. **112**:2377-2380 (June 10) 1939.

5. Morrison, D. R.: Risk of Surgery in Heart Disease, Surgery **23**:561-570, 1948.

6. Hannigan, C. A.; Wroblewski, F.; Lewis, W. H., and La Due, J. S.: Major Surgery in Patients with Healed Myocardial Infarction, Am. J. M. Sc. **222**:628-639 (Dec.) 1951.

7. Mallory, G. K.; White, P. D., and Salcedo-Salgar, J.: Speed of Healing of Myocardial Infarction, Am. Heart J. **18**:647-671 (Dec.) 1939.

8. Smith, C.: Length of Survival after Myocardial Infarction, J. A. M. A. **151**:167-170 (Jan. 17) 1953.

9. Master, A. M., and Dack, S.: Rehabilitation Following Acute Coronary Artery Occlusion, J. A. M. A. **115**:828-832 (Sept. 7) 1940.

10. Levine, S. A., and Rosenbaum, F. F.: Prognostic Value of Various Clinical and Electrocardiographic Features of Acute Myocardial Infarction, Arch. Int. Med. **68**:1215-1231 (Dec.) 1941.

11. Boas, E. P.: The Natural History of Coronary Artery Disease of Long Duration, Am. Heart J. **41**:323-331 (March) 1951.

Injuries of the Liver

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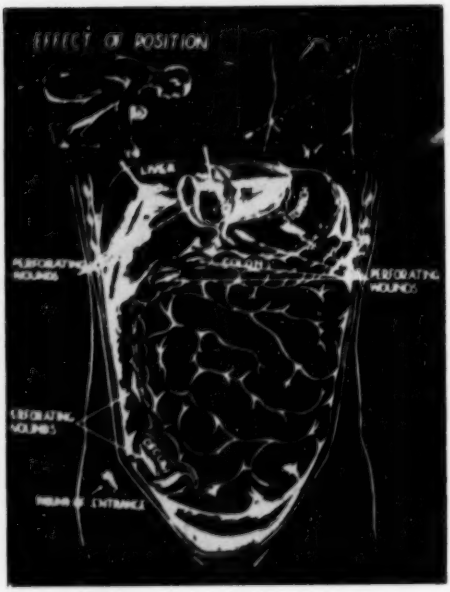
Injuries of the liver whether blunt or penetrating in nature are occurring with increasing frequency and severity. In spite of this, the average surgeon will not be called upon to care for more than an occasional patient with such an injury. Estes [1] pointed out in 1953, when making the annual oration on trauma before the American College of Surgeons, that unless the individual surgeon has had war experience in the therapy of abdominal trauma he is not likely to avoid the pitfalls that beset attempts at successful treatment of these lesions.

The present study consists of, first, an analysis of my personal experience with wounds of the liver seen in civilian practice; second, a review of the liver-injury cases admitted to a city-county general hospital during the last 10 years (1944 to 1954, 81 cases), and, third, a report prepared at the close of the last war for the Surgeon General's office on 829 cases of liver injuries, representing all types, cared for by myself and other members of the medical group with which I was associated.[2]

The seriousness of an injury to the liver is dependent upon three factors: error in diagnosis, presence of associated lesions, and improper therapy. The liver, the largest and heaviest organ in the body, because of its rather superficial location, is extremely vulnerable to blunt trauma or penetrations of both the lower chest and the upper abdomen. The liver, however, may be injured after penetrating injuries in any portion of the abdomen (Figure).



Effect of position on visceral wounds. Reproduced by permission from Madding, G. F.; Lawrence, K. B., and Kennedy, P. A.: Forward Surgery of the Severely Wounded, Washington, D. C., The Surgeon General of the U. S. Army, Aug. 27, 1945, p. 102.

It has been demonstrated that the liver possesses remarkable regenerative and recuperative powers, and clinical as well as experimental removal of either lobe has been performed without serious disturbance of its function.* However, after massive blood loss (35% or more), the functional reserve of the liver has been shown to be impaired.† In particular it has been demonstrated that in shock the liver cannot synthesize proteins such as fibrinogen and prothrombin.‡

PATHOLOGY

Injuries of the liver may be classified as direct and indirect. Direct injuries result

Read at the Sixty-Second Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Dec. 3, 1954.

* References 3 and 4.
† References 5 and 6.
‡ References 7 and 8.

chiefly from penetrating objects with varying factors of size, velocity, and direction and constitute by far the larger group. The magnitude of the injury, when secondary to gunshot wounds, is primarily dependent upon the explosive effect of the agent rather than its size. In these, the wound of entrance is smaller than that of exit. Tissue involvement is not confined to the area immediately surrounding the path of the projectile but extends outward for a variable distance, as seen in wounds of muscle. There may be associated vascular damage in the form of tears of large vessels, with hemorrhage and severance of normal blood supply producing further devitalization with necrosis which is both vascular and bacterial in origin. The main hepatic vessels and bile ducts, however, are infrequently involved because of their protected position on the inferior surface of the liver, and persons with injuries about the hilum of the liver rarely survive to come to treatment because of involvement of other vital structures in this location. In penetrating injuries of the lower thorax, whether due to external objects or fractured rib ends, the dome of the liver is most frequently involved and the right more often than the left in the ratio of 7 : 1. With such an associated wound of the diaphragm, extravasated blood and bile may find access to the pleural space and result in complications to be described later.

As opposed to direct trauma, nonpenetrating injuries have a lesser incidence (Sparkman series, 8% [9]; city-county general hospital series previously referred to, 20%). Blunt or nonpenetrating injuries of the liver may be classified as to severity, ranging from those in which there is rupture of the liver with simple laceration of Glisson's capsule, representing minimal trauma, to those in which there is a central rupture of the liver with extensive hemorrhage into the parenchyma. The pathological disturbances are similar in both types of wounds. After cessation of hemorrhage, there remains drainage from the biliary system proportional to the amount of injury. These wounds may produce marked systemic manifestations, often out of proportion to the degree of tissue damage. During the period after the injury, shock may be profound and not always proportional to blood loss. When biliary extravasation occurs, shock may result from the effects of bile salts, which constitute the toxic component of bile. When bile is retained in the peritoneal or pleural cavities, it attracts plasma in accordance with the osmotic principle, thus producing lower blood volume and greater shock. Here, as elsewhere, the knowledge of the practical implications of wound and septic shock, as well as hemorrhagic shock, make possible far more effective treatment at this stage. For, although the hemodynamic disturbance in the peripheral circulation is essentially the same in all types of shock, a certain number of patients with traumatic shock will be found refractive to fluid volume therapy alone.§

DIAGNOSIS

The diagnosis of injuries of the liver when associated with penetrating injuries about the lower chest or upper abdomen is not difficult. The diagnosis of injuries of the liver not associated with penetrating wounds presents a great problem. There are no signs or symptoms which are pathognomonic of this condition, and it should be remembered that symptoms of intra-abdominal injury may be delayed and not become manifest for a number of hours. Unconsciousness seen with concomitantly occurring head injuries may mask the abdominal symptoms, but shock is rarely seen in uncomplicated cranial injuries.[10] Severe head injuries exhibit signs of embarrassment related to the vital centers, namely, hypertension, slow pulse, cyanosis, and rising temperature and most often result from increased intracranial pressure. In contrast, the signs of rupture of the liver in the absence of penetrating wounds are chiefly those of hemorrhage and shock, with associated peritoneal and diaphragmatic irritation. Tenderness and distention with some rigidity of the abdomen

§ References 5 and 6.

are common. In the rare case of subcapsular rupture, a tender mass may be palpable. In central rupture, blood, because of its entrance into the biliary tract, may appear in the intestinal tract or the liver may become enlarged. Abdominal pain is the commonest complaint. It is usually severe in nature and aggravated by deep breathing or motion. Overlying soft-tissue injury or fractured ribs should markedly increase the suspicion of an underlying solid viscus injury. The presence or absence of peristalsis may be of help in differentiating conditions which tend to obscure the diagnosis of rupture of the liver; contusion of the anterior abdominal wall is one of the most frequent. This condition may present a similar picture; however, in the latter instance the pulse rate, blood pressure, and blood picture are generally normal, with the absence of the facial pallor which is so often seen when the injury is more serious. Frequently, the presence or absence of tenderness of the pelvic peritoneum as determined by rectal examination will aid in establishing the presence of irritation from blood and bile which may have gravitated to this region.

Once the diagnosis has been made of a ruptured solid viscus within the abdominal cavity, the chances are equal of it being either spleen or liver, and occasionally it is both. Needle aspiration, peritoneoscopy, and roentgen studies made with or without radiopaque substance have been suggested as an aid in establishing a positive preoperative diagnosis, but these methods have little to recommend their routine usage. On occasions it will be impossible to establish a positive diagnosis of a ruptured viscus preoperatively. Where there exists a reasonable doubt and the patient is not improving on conservative treatment, exploration is indicated. For, as Allen [11] stated in 1931, far less harm comes from the unnecessary exploration of a doubtful case than from waiting until the diagnosis is evident. This tenet certainly holds today because of the increased safety associated with abdominal exploration.

TREATMENT

Changes in the local care of liver wounds were slight in degree during the 70-year period elapsing from the reporting time of the first such case surgically treated (Bruns, 1870, cited by Sparkman [9]) and the last war. Such local treatment varied from none to the use of the cautery for control of bleeding. Others recommended the use of Sano Adhesive, which was painted on the liver-wound edges, after which they were to be pressed together for three minutes, and this reputedly provided hemostasis and permanent adhesion of the liver edges.‖ Other local treatment consisted in the occasional use of sutures for approximating purposes in fractures and lacerations of the liver followed by the almost universal employment of the gauze pack. Drainage, save for that which could be accomplished by use of such packs, was rarely mentioned. Attention was directed chiefly to the control of hemorrhage.¶

Preoperative treatment is directed toward establishing a diagnosis of the existence of an internal abdominal injury, to the care of existing shock, and to the preparation of the patient for surgery. Hemorrhagic shock must be treated in the usual manner, with the giving of blood before, during, and after operation by the drip method unless the seriousness of the condition warrants transfusion under pressure.

Although autotransfusion has been recommended, it is contraindicated, for this blood is usually mixed with bile and toxic products which result from autolysis of hepatic tissue. Death from anuria in such cases has occurred after autotransfusion. The use of electrolytes and antibiotics, relief of respiratory embarrassment, and pain control are paramount. The routine use of the nasogastric tube prior to, during, and after surgery is of considerable importance.

The definitive treatment of all liver wounds is surgical. Operative intervention is impera-

‖ References 12 and 13.

¶ Recently, control of liver hemorrhage by split-thickness skin grafting has been used successfully in the experimental animal.[26]

tive because of the high mortality attendant on the nonoperative treatment (62% in the city-county general hospital series studied), and delay increases the operative risk and the probability of infection associated with other complications. There are three factors which must be considered during an exploratory operation in such a patient: bleeding, destruction of hepatic tissue with drainage of bile into the peritoneal and/or pleural cavities, and associated intra-abdominal or intrathoracic injuries. It has been noted by surgeons of experience with this problem that by the time operation is performed bleeding from the liver has often ceased.# Of the series of 829 liver wounds previously referred to, active bleeding was still present in only 9% at the time of exploration.[2] In 91% of the cases, therefore, spontaneous hemostasis had occurred.

The large amount of free blood in the peritoneal cavity, frequently seen on opening the abdomen of a patient with a liver injury, is often misinterpreted as representing a liver wound which is still actively bleeding. After reaching the hilium of the liver both the hepatic artery and the portal vein branch rather promptly into smaller ramifications. Unless a hilar injury is sustained or the wound penetrates deeply into the liver, continued serious bleeding will be unusual.

The proper time of operation varies with the severity of the injury, the presence or absence of associated injuries, and state of shock. When the latter is mild, intravenous therapy is instituted and immediate surgery carried out. When shock is more profound, it is preferable to administer to the patient 1 to 2 liters of whole blood, and if recovery from shock is not occurring surgery should be instituted. To delay operation and administer blood beyond the above limit to a patient who may be having continued intra-abdominal bleeding or whose shock is due to other pathology such as altered pulmonary physiology in thoracoabdominal wounds or to sepsis will be of little profit and may delay exploration to such a point that no operative procedure can safely be carried out.

There is a difference of opinion as to the specific surgical procedures to be used in the treatment of wounds of the liver. Most methods deal, to a degree, with control of bleeding, the repair of the defect, and the establishment of drainage. How the latter is accomplished is of the greatest importance.

The type of incision will vary with the injury sustained. Vertical incisions will be found in most instances to be advantageous for such wounds and were utilized in 90% of this series of cases.[2] In blunt injuries of the abdomen—if there is a question of injury of the spleen as well as the liver—the transverse incision will have obvious advantages. Liver wounds sustained in thoracoabdominal injuries may be cared for by the thoracic, abdominal, or combined approach, depending upon the extent of the injury.

On opening the peritoneal cavity of the patient who has sustained a liver injury, all detached liver fragments, blood, and blood clots should be removed. The most efficient method of accomplishing this is by the use of the cupped hand serving as a scoop or by using a moist lap sponge. Little reliance should be placed upon the suction apparatus, for it is inefficient in such cases. It is time-consuming and ineffective because of the numerous clots and detached liver fragments which are often present. Pieces of hepatic tissue may be damaged and the circulation so impaired as to result in necrosis. All irreparably damaged hepatic tissue must be removed, which includes all detached pieces of liver and fragments that are loosely attached by a small piece of tissue, for these inevitably undergo necrosis and on occasion require removal of the sequestrum. Débridement, however, to more than this extent will rarely prove practical.

In penetrating injuries the foreign body should be removed if it lies within the liver. Suture of the ruptured liver for cases in which the defect is one of laceration or fracture may be carried out. Interrupted sutures of large caliber, with the use of round tapered

References 14 and 15.

needles, should be introduced at least an inch back from the wound edges. When possible, the sutures should extend as deeply into the liver substance as the base of the laceration in in effort to obliterate any dead space. To control venous ooze and to serve as a space-filler when needed, a number of agents have been employed; these include absorbable gelatin sponge (Gelfoam), oxidized cellulose (Oxycel), or one of the autografts such as peritoneum, muscle, or omentum. Use of such agents, however, may retard healing of the wound because of delayed absorption of the hemostatic agent. I have recently had occasion to drain a subphrenic abscess 27 days after the initial treatment of a liver wound by another physician. At the time of the abscess drainage, absorbable gelatin sponge was found, and the large fracture of the right lobe of the liver which had been sutured originally over the above agent was gapping. Other complications have been reported following the use of oxidized cellulose in and about the liver.* Some of these are subphrenic and subhepatic abscesses, persistent biliary fistulae, intestinal obstructions from adhesions, and erosion of the oxidized cellulose through the intestinal wall. In the latter case (reported by Kidd [18]), the cellulose was found 38 days after it had been introduced at the initial operation, virtually intact in the ileum, where it had lodged.

It is known that the rate of absorption of the various hemostatic agents depends upon a number of factors, including the amount of material used, pH of the tissue fluids, and other foreign matter which may be present. Any foreign body, however absorbable, will delay wound healing, especially in the presence of infection. Bleeding or bile drainage, if significant, should be controlled by individual ligation of the vessels, with the use of interrupted Atraumatic sutures of small caliber, and followed by the procedures mentioned above. Temporary compression of the vessels in the hepatoduodenal ligament by use of the fingers or by a rubber-covered clamp, as recommended by Cohn,† will prove helpful in controlling bleeding while the individual bleeding points in the liver are sutured. In the patient with a massive tear of the liver in whom control of bleeding is not satisfactorily accomplished by use of these measures ligation of the hepatic artery should be considered.[21]

The establishment of adequate external drainage of bile and products of tissue injury, which means, when the occasion warrants (i. e., deep hepatic tears), the placing of drains within the liver substance proper, is the most important feature in the surgical care of all liver wounds. The importance of this fact is not yet fully appreciated, for in one of the more widely used texts (reprinted in 1953) in the field of surgery, the following treatment is recommended for contusions and lacerations of the liver: "Careful packing generally is efficient both in checking the hemorrhage and furnishing the necessary drainage." [22] The traditional gauze pack so advocated will not function as a drain, and when it is used for this purpose the morbidity and mortality will be increased. Temporary packs may be effective in checking bleeding during the operation. These packs, however, should be removed and adequate drainage established before the incision is closed.

It was found in the series of 829 liver wounds that when the use of drains only in treatment rose from 48.5% to 87.4%, with a corresponding reduction in the use of gauze packs from 34.1% to 9.6%, the mortality rate, paralleling this trend away from packs, dropped from 29.8% to 16.9%.[2] These mortality figures are for all abdominal injuries with liver involvement, and in over 90% of these cases other organs were involved. In 339 cases in which the liver alone‡ was injured, the mortality rate was 9.7%.[2]

In the series of 81 cases of liver injuries, admitted to a city-county general hospital (1944-1954) during the past 10 years, there

* References 16 to 20.

† Cohn, R.: Personal communication to the author.

‡ Only visceral organ involved.

was an over-all mortality of 13.5%. When the liver was the only organ involved, the mortality was 6.4%. This multiplicity factor (multiple viscera involvement) is important, as noted in the following tabulations, and is the most important single factor in prognosis.

Effect of Multiple Organ Involvement on Mortality Rate (829 Cases)[2]

	Mortality Rate, %
Liver uncomplicated	9.7
Liver plus 1 other organ	26.5
Liver plus 2 other organs	39.7
Liver plus 3 other organs	54.8
Liver plus 4 or more other organs	84.6

Effect of Liver Injuries on Mortality in Combination with Other Organs[2]

Name of Viscera	No. of Cases	Mortality Rate, %
Liver only	339	9.7
Liver plus stomach-duodenum	64	31.3
Liver plus jejunum-ileum	15	13.3
Liver plus colon	34	32.3
Liver plus kidney	77	25.9

Principle Causes of Death (224 Cases)[2]

	Cases, %
Shock	51.4
Pulmonary complication	17.0
Peritonitis	12.7
Renal failure	8.5
Other causes	10.7

In the group of 81 cases with liver injuries previously referred to, it was found that 20% presented complications after treatment. These complications were as follows:

Parotitis
Jaundice
Fever
Abscesses
  Subphrenic
  Subhepatic
  Intrahepatic
  Pelvic
  Abdominal wall
Peritonitis, localized and generalized
Secondary hemorrhage
Sequestration of liver requiring surgical removal
Pneumonitis and pneumonia
Pleurisy with and without effusion
Persistent biliary-tract fistulae
Acute suppurative hepatitis
Intestinal obstruction
Intrahepatic hematoma

In a series of 98 wounds of the liver reported by Burford,[23] it was found that after their initial treatment 25% presented complications. These were complications resulting from inadequate drainage. The gauze pack, whether used alone or in conjunction with drains, tends to act as a tampon, causing necrosis, pocketing of bile, exudate, and the formation of innumerable complications. In all thoracoabdominal wounds the diaphragm will be perforated. The bile, blood, and exuded fluids prevented from draining externally by liver packs may force their way through the sutured diaphragmatic wound. This in turn is followed by bile empyema or biliary thoracic fistulae. Other complications which have been seen after the use of the gauze pack are intrahepatic necrosis, abscess, secondary hemorrhage with massive hemobilia,[24] hepatitis, pleuritis, and bile peritonitis followed by common duct stricture.[25] In addition, when drainage is not adequate and subphrenic accumulations occur, there follows an increased incidence of pulmonary complications, particularly in the lower lobes. A less important but significant feature is the pain associated with removal of a large liver pack. It may necessitate the use of an anesthetic, thus adding to the postoperative problem. Immediate hemorrhage after removal of a gauze pack used in the treatment of liver wounds may occur, and fatal hemorrhages have been reported. I have observed an autopsy on such a patient. In an effort to avoid such bleeding, very early removal of the pack has been practiced in some cases, with premature closure of the external drainage wound. It is virtually impossible to reinsert adequate drains down to the wound site after removal of such a pack and pocketing of bile, and exudate is likely to result. Not only is immediate hemorrhage following pack removal a problem but the use of packs leads to a higher incidence of secondary hemorrhage because of the infected granulation tissue which forms behind them. Delayed healing of the liver wound covered with infected tissue occurs as with infected wounds in other locations.

The placing of the wick end of a Penrose cigarette drain to act as a clot-supporting surface against the superficial liver wound, which is still oozing, will in most cases control any residual bleeding and also provide drainage. When large and separate wounds are present, multiple drains should be inserted down to, and not infrequently into, the substance of the liver. Additional drains should be placed about the liver into the subhepatic and subphrenic spaces to prevent pooling of bile and exudate in these regions. All drains are delivered through a dependent drainage incision, usually placed subcostally in the anterior or midaxillary line. This drainage incision must be at least 1½ in. in length and cleanly incised through all layers of the abdominal wall to avoid constriction of the drains. They should not be brought to the exterior through the laparotomy or thoracotomy incisions, since this leads to a higher incidence of wound infection and disruption. Débrided wound tracts in penetrating injuries coinciding with the usual subcostal drainage location may be satisfactory.

The proper removal of drains holds as important a place in the treatment of liver wounds as does their initial placing. The shortening must be gradual, beginning usually on the fourth or fifth postoperative day. The drains are out, preferably, by the 10th or 12th postoperative day. Complete removal should be deferred, however, until drainage has virtually ceased. Rarely is a liver wound too small to require drainage. It is true that in some cases there will not be postoperative drainage, but there are no reliable criteria by which such cases can be selected preoperatively or at operation. Antibiotics should be used routinely. These drugs, however, will not effectively combat or eliminate the development of complications resulting from inadequate drainage.

SUMMARY

All suspected liver wounds should be explored, and of prime importance in their treatment is the establishment of adequate external drainage. Suggestions regarding the definitive care of liver wounds are made, and the general postoperative care will include the use of antibiotics and vitamin K. The other factors which govern the systemic therapy in patients with liver injuries are those which are effective in the postoperative management of all surgical patients.

DISCUSSION

Dr. Howard E. Snyder, Winfield, Kan.: Mr. President and Members: Dr. Madding is particularly qualified to speak on this important subject because of his personal experience in the war and since, and because of the opportunity he had to review the cases of the second auxiliary surgical group. He has touched upon some very important points. The most important, of course, is the method of drainage of the liver wound. With all he has had to say about this I am in perfect agreement. I believe the practices he has outlined are the best and the most satisfactory.

There were some things in the text of his paper which he did not have time to cover, which are of importance, and I think they should be emphasized here.

First, in the diagnosis of nonpenetrating wounds of the liver the surgeon must be ever alert to rupture of a solid or hollow viscus in the abdomen, and an exploration of the abdomen in questionable cases should be done early. This point is emphasized even more in his full text.

His reference to suture of the liver—to condemn it except in superficial lacerations—is a point that should be remembered.

In gunshot wounds of the liver the diaphragm is frequently involved. Unless the diaphragm is securely closed and unless the liver is adequately drained below, a bile empyema is apt to result.

The approach to the thoracoabdominal wound involving the liver is a question which has come up many times, and I think it should be pointed out that in many wounds involving the liver, some of which are penetrating wounds with a .30 caliber bullet or a shell fragment lodged in the liver itself, the best approach is through the thorax or through a combined thoracoabdominal incision.

In these cases drainage not only should be instituted below, as Dr. Madding has outlined it, but the pleural space also should be drained. In saying this, one should not allow the impression to be gained that the liver is drained through the pleura. That has been done, and it has even been advocated that the diaphragm be sutured to the chest wall and drainage instituted through the diaphragm, the pleural space and the chest wall. That, we believe, and experience has shown, is a very bad practice. The diaphragm should be very securely closed in all wounds, and drainage of the liver wound should be instituted below the costal margin.

There was one recommendation that Dr. Madding made which I think might be questioned, and I should like to ask him about it, and that was that perhaps the hepatic artery should be ligated. I should like to known whether he or any of the other members of his group in World War II performed ligation of the hepatic artery. It has not come to my attention in the management of wounds of the liver, and from more or less recent experience in ligation of the hepatic artery for cirrhosis and portal hypertension, I should be rather inclined to think that the traumatized liver might tolerate it less well than does the cirrhotic one.

Dr. Samuel Beresford Childs, Denver: This paper by Dr. Madding is certainly most timely and in line with the fine paper given last night on the frequency of automobile accidents, in which the accident in no sense favors any one particular region. I think the dissemination of information on this subject is very important.

The therapy of the fractured spleen has been well established, but certainly that is not true of liver injuries. As those of us who attended some of these cases during the last war can well attest, the often novel and highly original methods of treating liver injuries were very illuminating.

The principal point that I would like to stress, which Dr. Madding has already stressed, is that the liver is not like the spleen. The parenchyma of the liver when fractured does not present the problem of bleeding per se. Obviously, a torn blood vessel is a torn blood vessel, whether in the liver or somewhere else, and it must be attended to.

The parenchyma of the liver itself does not give us the problem of hemorrhage but that of bile extravasation, and therefore the principal thing we have to deal with is drainage to the outside of that bile which extravasates.

Hemorrhage from the liver parenchyma is not going to cause death.

In dealing with this physiology of bile extravasation rather than hemorrhage, let us not resort to something unnecessary, such as a pack. If we are going to use a pack, let us also remember that it has to be removed, and that is where the difficulty arises.

Using oxidized cellulose (Oxycel) or absorbable gelatin sponge (Gelfoam) is even worse, I believe, than attempting to use a pack, which is always removed, and the pious notion is often entertained (unjustly so) that in using oxidized cellulose it can be sutured in place. That has resulted in late foreign-body reactions.

Dr. J. T. Reynolds, Chicago: Several things should be said to emphasize the importance of proper drainage. Proper drainage must be effective, must be adequate, and must not carry danger. To accomplish this, the following suggestions are made: Adequate drainage can be provided only with several drains. The author prefers the use of two Penrose drains placed together. Second, the abdominal wall must not be closed too securely. If one inserts several Penrose drains and yet closes the abdominal wall too tightly, drainage will not be effective; the abdominal wall should be closed loosely enough so that material can get out of the peritoneal cavity. Preferably, the area around the drains should admit two fingers. Third, drains must be anchored in place so that they will provide continuous drainage for any amount of leaking material. This will, of course, prevent displacement during the technical problems attending closure. If there is any question of rapid accumulation of liquid material during the early postoperative period, sump drains supplementing the Penrose drains will usually supply negative pressure and encourage the early evacuation of such fluid. Occasionally, counterincisions may help remove this early accumulation of fluids. Stab wounds as such I believe should be avoided, since by their very definition they imply a small and therefore inadequate opening in the abdominal wall. All of these principles of drainage are particularly important in cases in which the liver is injured, where the leakage of bile cannot be predicated or prevented.

Dr. Ralph H. Loe, Seattle: I enjoyed Dr. Madding's paper very much. It brought back fond memories to me of experiences in the last war which we now like to talk about but which for some time we did not particularly like to mention.

I remember one chap who was brought aboard our hospital ship in an extreme state and who died shortly after his arrival. At postmortem examination, an extensive shrapnel wound of the liver, inadequately drained, was found plus a large loose fragment of liver and a considerable quantity of bile. I am sure we are all aware this was a bad thing to do, but it was not forcibly brought to my attention except at that time. The piece of liver was floating and necrotic, and there was gas gangrene associated with the abdominal infection, from which he died.

I certainly second all of the technique described by Dr. Madding in the handling of these injuries.

Dr. Gordon F. Madding, San Mateo, Calif.: I want to thank Drs. Snyder, Childs, Reynolds, and Loe for their discussion.

In reply to the two questions brought up regarding bleeding: spontaneous hemostasis occurs frequently in liver wounds. In the 829 series, in 91% of these cases there was no active bleeding at the time of exploration. This is a fact which has been noted by other men dealing with liver injuries.

Regarding hepatic artery ligation in liver injuries, I have never had occasion to resort to

hepatic artery ligation for the control of bleeding. The procedures outlined in the text have been adequate for this purpose in my personal experience. The suggestion regarding hepatic artery ligation, as pointed out in the text, was made by Dr. Reinhoff, who felt that this may be indicated in the very rare patient in whom bleeding cannot be satisfactorily controlled by other measures.

The point regarding drainage made by the discussant was well taken. This subject is covered thoroughly in the text and the point stressed that drainage should not be carried out through the operative wound but through a separate stab wound placed in the anterior or subcostal region. The incision should be at least 1½ in. in length and cleanly incised through all layers of the abdominal wall to avoid constriction of the drains.

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REFERENCES

1. Estes, W. L.: Present Day Problems in Nonpenetrating Abdominal Trauma, Oration on Trauma presented at the Clinical Congress, American College of Surgeons, Chicago, Oct. 7, 1953.

2. Madding, G. F.; Lawrence, K. B., and Kennedy, P. A.: Forward Surgery of the Severely Wounded, Second Auxiliary Surgical Group, James H. Forsee, Commanding Officer, transmitted to Surgeon General U. S. Army, Aug. 27, 1945, pp. 307-326.

3. Pack, G. T., and Baker, H. W.: Total Right Hepatic Lobectomy, Ann. Surg. **138**:253-258, 1953.

4. Quattlebaum, J. K.: Massive Resection of the Liver, Ann. Surg. **137**:787-796, 1953.

5. Fine, J.: Relation of Bacteria to the Failure of Blood Volume Therapy in Traumatic Shock, New England J. Med. **250**:889, 1954.

6. Child, C. B.: The Hepatic Circulation and Portal Hypertension, Philadelphia, W. B. Saunders Company, 1954, p. 126.

7. Frank, E. D.; Frank, H. A., and Fine, J.: Traumatic Shock: Plasma Prothrombin Activity in Hemorrhagic Shock in Dog, Am. J. Physiol. **167**:499-507, 1951.

8. Frank, E. D.; Frank, H. A., and Fine, J.: Traumatic Shock: Plasma Fibrinogen in Hemorrhagic Shock in Dog, Am. J. Physiol. **162**:619-631, 1950.

9. Sparkman, R. S., and Fogelman, M.: Wounds of the Liver, Ann. Surg. **138**:690-718, 1954.

10. Tinsley, M.: Penetrating Wounds of the Head, Surgery **19**:535-542, 1946.

11. Allen, A.: Internal Injuries Without Penetrating Wounds, New England J. Med. **205**:34, 1931.

12. Babcock, W. W.: Principles and Practices of Surgery, Philadelphia, Lea & Febiger, 1944, p. 1037.

13. Sano, M. E., and Holland, C.: Coagulum Technique in Traumatic Rupture of the Liver in Dog and Man, Science **98**:524, 1943.

14. Hinton, J. W.: Injuries to the Abdominal Viscera: Their Relative Frequency and Their Management, Ann. Surg. **90**:351, 1929.

15. Smith, W. S., and Hastings, T. N.: Traumatic Rupture of the Gall Bladder, Ann. Surg. **139**:517-520, 1954.

16. Vanderhoof, E. S., and Meredino, K. A.: Unfavorable Reactions to Oxidized Cellulose (Oxycel) in Bed of Gall Bladder: Retained Oxycel Sponge Syndrome, Arch. Surg. **58**:182-188, 1949.

17. Cawkwell, W. I.: Unfavorable Reaction to Oxidized Cellulose in the Abdomen, New Zealand M. J. **51**:178-179, 1952.

18. Kidd, H. A.: Acute Intestinal Obstruction From Foreign Bodies, Brit. M. J. **2**:832, 1951.

19. De Prizo, C. J.: Fatal Intestinal Obstruction Due to Oxidized Cellulose (Oxycel), J. A. M. A. **148**:118, 1952.

20. Frantz, V. K.; Clarke, H., and Lattes, R.: Hemostasis with Absorbable Gauze, Ann. Surg. **120**:181, 1944.

21. Rienhoff, W. F., in discussion of Quattlebaum, J. K.: Aneurysm of the Hepatic Artery: Report of 3 Cases, Ann. Surg. **139**:759, 1954.

22. Anson, B., and Maddock, W., in Callander, C. L.: Surgical Anatomy, Ed. 3, Philadelphia, W. B. Saunders Company, 1952, p. 429.

23. Burford, T. H.: Review of 1000 Cases of Thoracic Injuries, Bull. U. S. Army M. Dept. **89**:70-72, 1945.

24. Sparkman, R. S.: Massive Hemobilia Following Traumatic Rupture of the Liver, Ann. Surg. **138**:899-910, 1953.

25. Chenoweth, A. I., in discussion of Sparkman, R. S., and Fogelman, M. J.: Wounds of the Liver, Ann. Surg. **139**:717, 1954.

26. Masters, F.; Georgiade, N.; Horton, C., and Pickrell, K.: Control of Liver Hemorrhage by Split-Thickness Skin Grafting: Experimental Study, A. M. A. Arch. Surg. **69**:718-725, 1954.

Pressures in the Pancreatic and Common Ducts

Values During Fasting, After Various Meals, and After Sphincterotomy; An Experimental Study

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Normal physiologic pressures in the pancreatic and common bile ducts have proved difficult to measure. Various methods of recording pressures have been described,* but all the methods have involved either producing a fistula or occlusion of the major duct by the recording cannula. The preliminary objective of the present investigation was to develop a method whereby the pressures could be recorded without producing a fistula or occluding the ducts and without interfering with any sphincteral mechanism which might control the flow of bile or pancreatic juice from the ducts into the duodenum. A method was developed which satisfactorily met these criteria, a method by which simultaneous recordings of pressures in the pancreatic duct, in the common bile duct, and in the duodenal lumen could be made from cannulae placed in these organs. The experiments were carried out on trained dogs which had fully recovered from the operative procedures of placing the cannulae in the ducts. Studies were made on pressures in resting animals both during fasting and after various types of meals. In two instances, the effects of sphincterotomy were observed.

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From Mayo Foundation, Fellow in Surgical Research (Dr. Parry), and Mayo Clinic and Mayo Foundation, Section of Surgery (Dr. Hallenbeck) and Section of Surgical Research (Dr. Grindlay).

* References 1 to 7.

METHOD

Dogs of quiet disposition weighing approximately 14 kg. were chosen. The animals were trained to lie quietly on a mattress before recordings were made. Studies were not begun until one to three weeks after operation, by which time the incisions were healed and, as was confirmed several times by laparotomy, reaction of the pancreas and liver to surgical trauma had subsided. The animals used were fed on a fixed diet of low bulk to ensure completion of digestion in 24 hours and thereby establish a standard condition for the experiments. The tubes were considered to be working satisfactorily when there was a free flow of pancreatic juice, bile, and duodenal contents from them and when there was no obstruction to the flow of water from the manometers when the pressures were raised above those in the ducts.

A transpleural, transdiaphragmatic approach was used for the operation, at which flexible, transparent polyvinyl tubes† were placed as cannulae in the ducts of the liver and pancreas and in the duodenum. The incision was made on the right of the chest through the 10th interspace, and the ribs were widely retracted. The right lung was packed off, and the diaphragm was opened in the line of its fibers.

Cannulation of Pancreatic Duct (Fig. 1)

The major pancreatic duct was identified at its junction with the duodenum, and a small opening was made near its duodenal end. A silver-plated, tapered introducer, described in a previous paper,[8] 4 in. in length and carrying a size 24 polyvinyl tube, was passed up the main pancreatic duct of the tail of the pancreas for a distance of 3 to 4 in. and then thrust out through the side wall of a tributary duct and the substance of the pancreas. The polyvinyl tube was drawn out until its lower end was lying in the major duct about 1 cm. above the junction of the duct and duodenum and was

† Polyvinyl (Transflex) tubing used in this study was furnished by Irvington Varnish & Insulation division of Minnesota Mining & Manufacturing Co., Irvington 11, N. J.

anchored in this position by a small mattress suture placed through the peritoneum and parenchyma of the pancreas at the site where the tube emerged from the gland, and through a piece of surgical polyvinyl (Ivalon) sponge‡ which had a slot made in it to receive the tube. The nonabsorbable (cotton) suture was tied firmly but not tightly around the tube about four or five times in a figure-of-eight manner so as to allow friction with the cotton to prevent the tube from slipping from its position. The opening made initially in the duct was closed transversely by one or two sutures of fine nonabsorbable (silk) sutures.

Fig. 1.—The positions of the plastic tubes. Top: The open tip of the tube lies in the common bile duct. Thence the tube passes up through the hepatic duct and finally through the liver parenchyma. It is anchored to the liver surface by means of a cotton mattress suture placed in the liver parenchyma and a small pledget of surgical polyvinyl sponge placed on the capsule, and by tying the suture several times about the tube. From the liver the tube (shown in black) passes intraperitoneally to the anterior abdominal wall and finally through a tiny stab opening in the wall. Middle: The pancreatic duct tube is shown with its open tip in the main duct and following a comparable course. Bottom: The duodenal tube is shown in position, the curved intraduodenal tip pointing downward.

Cannulation of Common Bile Duct (Fig. 1)

This procedure was the same as that previously described by Grindlay and associates,[6] with the exception that cholecystectomy was not performed. The introducer was passed into the lumen of the gall bladder through a puncture hole, thence down the cystic duct into the common bile duct, through the papilla into the duodenum, and out through the duodenal wall. The introducer was pulled through until a small length of tube was outside the duodenum. The introducer was then detached from the lower end of the tube and attached to the upper end, which was protruding out of the gall bladder. By pulling of the tube at its duodenal end and guiding from above, the tube and introducer were withdrawn until the tip of the introducer was in the lower part of the common bile duct. The introducer was then guided up a right hepatic duct as far as possible and thrust out through the liver substance. The tube was pulled out until its lower end was lying 1 to 1½ in. from the junction of the duct and duodenum.

Cannulation of Duodenum (Fig. 1)

For this procedure a size 16 polyvinyl tube was specially prepared. Two inches from the end of the tube a right angle bend was made by softening the area by immersion in acetone and rehardening in hot water in the desired curve without producing an acute flexion. Above the bend a simple cuff and a flanged cuff of size 14 polyvinyl tube were placed about ¼ in. apart. The tube was introduced into the duodenum through the hole made in cannulating the common bile duct, the simple cuff being made to lie within the lumen and the flanged cuff on the outside. The two arms of the flange were sutured to the duodenal wall. A square of surgical polyvinyl sponge was passed over the tube, fitted on to the flange and sutured to the duodenal wall with six interrupted fine black nonabsorbable (silk) sutures.

The three tubes were brought outside the abdominal wall near the midline in the xiphoid notch through puncture holes made by the introducers. Liberal lengths of tubes were left between the organs and the abdominal wall to prevent tension and to allow movements without displacement of the tubes. The slack in the tubes was guaranteed by tying polyvinyl sponge around each one on the inner aspect of the abdominal wall. Polyvinyl sponge made an excellent medium for fixation of the tubes to the organs cannulated and to the abdominal wall, since it quickly becomes adherent by fibrous tissue growing into its interstices from the area with which it is in contact.

Division of Duodenal Muscle Over the Pancreatic and Common Bile Ducts in Their Intramural Course: Surgical Procedure

The animals were prepared surgically by the method previously described. At the same operation the duodenal muscle over the intramural part of the pancreatic duct was divided carefully and the

‡ Surgical Ivalon sponge used in this study was furnished by the manufacturer, Ivano, Inc., Chicago, and is available from Clay-Adams, Inc., New York.

muscle fibers were separated until the duct was lying freely in the submucosa. The procedure for the common bile duct proved more difficult to perform, owing to its position and to the longer intramural course, and the end-result did not look as satisfactory, because the duct could not be freed so well without the danger of traumatizing the duct or the minor pancreatic duct.

Recording of Pressures

Water manometers fixed to a board with millimeter graph paper behind them were used. The board was fixed to a stand with a ratchet arrangement for varying the height of the board and manometers. The zero level for determination of pressures was taken as half the body thickness of the animals at the level of the 11th rib while the animal was lying on its left side.

Four types of meals were used in the studies. The daily diet of the animals was used as a standard meal and consisted of 16 oz. (454 gm.) of commercial dog food § consisting of horse meat well balanced with regard to essential salts and vitamins. A carbohydrate meal consisted of 10 oz. (283 gm.) of cracker meal mixed with water to a smooth paste. A fat meal consisted of 8 oz. (227 gm.), of a standard meal and an equal amount of lard. A protein meal consisted of 16 oz. (454 gm.) of lean horse meat. The weights were chosen to provide meals of approximately equal bulk.

Fasting pressures were recorded before each test meal, and the pressures were observed over a period of two hours after each meal. The pressures were recorded every 30 seconds during the period of observation.

Fasting pressures were recorded after 24 hours of fasting, and for the first few tests the pressures were observed for periods up to one-half hour. When the pressures became known within a certain range, the period of recording fasting pressures was shortened to about 15 minutes. Ten to 15 minutes were allowed for the animals to settle down on the table before any records were taken. The pressure immediately before feeding was considered the fasting pressure in each test.

§ Hill's dog food.

Results

Table 1 shows the mean fasting pressures in the pancreatic and common bile ducts in each animal and the range of the pressures recorded in each case. On the whole the fasting pressures in the pancreatic duct were fairly constant for individual animals, the greatest variation being 46 mm. of water. It was noticed that any disturbance exciting the animal or a restless state tended to cause a rise, particularly in the pancreatic duct pressure. This accounts for some of the higher pressures during the fasting state. In all the animals during every recording period the common bile duct pressure was considerably lower than the pancreatic duct pressure during the fasting state. There was greater minute-to-minute fluctuation of pressure in the common bile duct than in the pancreatic duct in each dog.

Table 1.—*Mean Pancreatic Duct and Common Bile Duct Pressures in Millimeters of Water After Twenty-Four Hours Fasting*

		Pancreatic Duct		Common Bile Duct	
Animal	Number of Records	Mean Pressure	Range	Mean Pressure	Range
1	7	80.2	68-97	28.2	3-47
2	4	80.2	71-94	50	44-54
3	8	97.8	74-120	63.4	49-94
4	16	98.5	88-131	58.1	40-70
5	17	104.5	97-119	56.4	41-87
Group	4*	91.06	80-108	47.9	32-64

* First four records for each animal.

Mean pancreatic and common bile duct pressures for the five animals were calculated as an average of the mean pressures of the first four runs for each animal, thus giving data from each animal equal weight. These figures of 91 mm. of water for the pancreatic duct and 48 mm. of water for the common bile duct are probably a good indication of the normal physiologic pressures within the two ductal systems during a fasting period.

TABLE 2.—*Pancreatic Duct Pressures in Millimeters of Water After Various Meals in a Group of Five Animals*

Type of Meal		Animals				
		1	2	3	4	5
Standard Meal	Number of records	4	3	2	4	4
	Mean rise*	32.5	46	11.75	33.5	33.75
	Range	21-43	35-54	7-16.5	26-43	23-45
	Maximal pressure	128	142	113	154	161
Fat Meal	Number of records	2	0	2	4	4
	Mean rise*	22	...	66.5	33.25	14.25
	Range	0	...	63-70	21-49	11-17.5
	Maximal pressure	109	...	190	145	121
Carbohydrate Meal	Number of records	0	1	1	4	4
	Mean rise*	...	28	16	49.75	32.1
	Range	...	0	0	25-62	25-40.5
	Maximal pressure	...	109	109	150	139
Protein Meal	Number of records	0	0	2	4	4
	Mean rise*	...	...	65.75	37.5	25.1
	Range	...	...	31.5-100	25-58	17-40
	Maximal pressure	...	...	198	155	146

* Mean difference between pressure during fasting and maximal pressure during two hours after feeding.

THE EFFECT OF MEALS ON THE PANCREATIC DUCT AND COMMON BILE DUCT PRESSURES

The response of the pressures to normal physiologic stimuli in the form of meals was considered to be of basic importance in developing this method of recording pressures.

It can be stated definitely that the pressures in the bile and pancreatic ducts were similar regardless of the type of meal fed. The response varied from day to day with the same meal in each animal.

In Tables 2 and 3 the mean maximal postprandial rise of pressure above the fasting level was calculated for each animal for each meal. The maximal pressure observed for each meal is noted in the tables. It can be seen from the tables that there is no consistent response to any meal in the group. The maximal pancreatic duct pressure after meals in the studies was found to be between 109 and 198 mm. of water, and the maximal common bile duct pressure, between 86 and 178 mm. of water.

The continuous variation from second to second in the duodenal pressure made it impossible to state the pressures with any accuracy. During the fasting period the intraluminal pressure in the duodenum is cer-

TABLE 3.—*Common Bile Duct Pressures in Millimeters of Water After Various Meals in a Group of Five Animals*

Type of Meal		Animals				
		1	2	3	4	5
Standard Meal	Number of records	4	3	2	4	4
	Mean rise*	44.5	43.5	39.75	44.5	71.5
	Range	31-61	38-49	38-41.5	29-63	53-93
	Maximal pressure	89	101	95	130	146
Fat Meal	Number of records	2	0	2	4	4
	Mean rise*	40.5	...	29	44	68.25
	Range	37-44	...	22-36	34-54	40-102
	Maximal pressure	89	...	93	108	155
Carbohydrate Meal	Number of records	0	1	1	4	4
	Mean rise*	...	52	24	50.75	97
	Range	...	0	0	40-61	74-131
	Maximal pressure	...	96	86	121	178
Protein Meal	Number of records	0	0	2	4	4
	Mean rise*	...	...	30.5	39	67
	Range	...	...	9-52	30-59	59-81
	Maximal pressure	...	...	108	103	134

* Mean difference between pressure during fasting and maximal pressure during two hours after feeding.

tainly lower than in the pancreatic duct or common bile duct, and following a meal the duodenal pressures fluctuate at a higher level, but it was not clearly shown in the records that the pressure in the ducts paralleled changes of pressure in the duodenum.

The periods of increased pressures in the two ducts and duodenum were in general similar in time of onset following a meal and in duration afterward. In some records the period of increased peristalsis in the duodenum following the passage of food into it from the stomach corresponded to the time of rapidly increasing pressure in the pancreatic duct and to some extent in the common bile duct. However, it was impossible to say whether food in the duodenum increasing the tone of the duodenal muscle had a mechanical effect in obstructing pancreatic flow or whether the known reflex and humoral increase in the flow of pancreatic juice after eating accounted for the rise in pressure.

A marked effect on the level of pressure in the two ducts and duodenum was obtained in two animals by increasing the bulk of a meal. In these two animals the volume of the carbohydrate meal was doubled. In one of those the pancreatic duct pressure rose to a maximum of 243 mm. of water, and in the other, to 216 mm. of water. In the first animal, the common bile duct pressure was the same as that obtained after the smaller carbohydrate meal, and the duodenal pressure, though raised 70 mm. of water above the fasting level, did not show greater fluctuations from increased peristalsis. In the second animal, with a maximal pancreatic duct pressure of 216 mm. of water, there was a simultaneous rise in common bile duct pressure to 178 mm. of water, and the duodenal pressure rose to over 200 mm. of water and remained at around three times the fasting pressure for a considerable time after the meal. It was felt that in these two cases sustained increased tone of the duodenal muscle and increased intra-abdominal pressure caused by the large bulk of the meal could have been factors responsible for the high pressures.

Figure 2 shows four graphs of pressure records in the pancreatic and common bile ducts taken before a meal and for a period of two hours after a meal. The particular meal is not specified, since the type of meal did not affect the pattern of the graphs. The four graphs reproduced were taken as being representative of the whole series of records. The graphs show that during the fasting period before a meal the common bile duct pressure was lower than the pancreatic duct pressure. In three of the graphs this order was kept throughout the period of observation after a meal. In the top graph, however, within a short period after the meal there was a rapid rise in common bile duct pressure above that in the pancreatic duct and the pressure remained at this level for a period of about 40 minutes. This was not a routine observation, and except for Animal 5 it occurred in only one or two tests in each animal. When it occurred, the rise of the common bile duct pressure over that in the pancreatic duct was only a matter of a few millimeters of water and usually lasted for only a few minutes. Animal 5 was an exception; in the majority of the tests of this animal the common bile duct pressure rose above that in the pancreatic duct and remained so for varying periods up to 60 minutes. This phenomenon was found in the early period after a meal and was probably due to emptying of the gall bladder, since it was observed that thick, dark green bile came out of the common bile duct tube during this time.

The responses of the pancreatic duct pressures are well shown in the four graphs (Fig. 2). In the top graph there was a gradual rise of pressure during a 30-minute interval after a meal. Thereafter the pressure remained on a level plateau and showed a slight but very gradual fall only at the end of two hours. In the second graph there was a more sudden elevation of pressure, which was maintained for about 1 hour, but the pressure had fallen to the fasting level 70 minutes after the meal. In the third graph there was a 20-minute delay after the meal before the pressure began to rise and, after a rapid

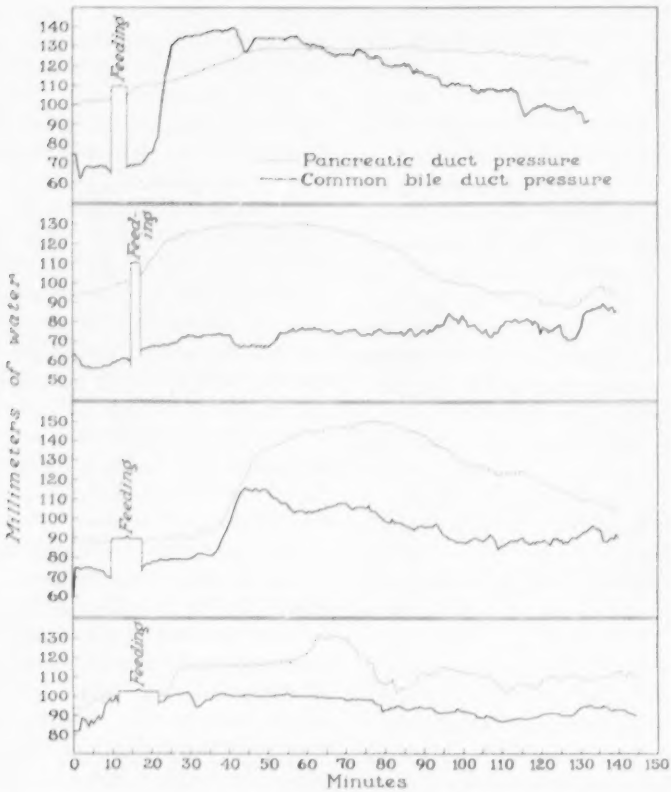

Fig. 2.—Graphs of pressure in the common duct and main pancreatic duct, showing the four commonest types of response to the feeding of a meal. Pressures in both the pancreatic and the common duct were regularly increased after feeding, but the time when the rise in pressure occurred and the height and duration of the rise varied. In the top graph, the interval after the feeding when biliary pressure exceeded pancreatic pressure appeared to coincide with emptying of the gall bladder.

increase, the pressure remained at a high level for about 60 minutes. A fairly rapid fall in the pressure then occurred, though at the end of two hours the pressure was still above the fasting level but gradually decreasing. In the bottom graph there was more variation in the pancreatic duct pressure. An initial rise of pressure immediately after the meal was maintained for 35 minutes before a further, more transient rise occurred. This was followed by a rapid decrease of pressure almost to the fasting level. During the second hour after the meal a further (though not so marked) rise occurred, and the pressure remained at this level for the whole remaining period of observation. The four types of responses of pancreatic duct pressures to meals shown and described are representative of all the patterns found in the whole series.

The graphs show that the response of the common bile duct pressure to meals was more variable and showed more fluctuations than the response of the pancreatic duct pressure. In the top graph there was a quick high rise in the ductal pressure, which went above that in the pancreatic duct. The high pressure was maintained for 50 minutes before a gradual but progressive fall occurred during the period of observation. This is a graph of pressures in Animal 5 and, as previously mentioned, was a very unusual pattern

in the other four animals. In the second graph the pressure changes were not as dramatic. A small rise in pressure occurred, which was generally progressive over a period of two hours after the meal. The highest pressure was reached at the end of two hours. In the third graph the common bile duct pressure followed that of the pancreatic duct in general, showing a 20-minute delay, then a plateau, and, finally, a gradual fall to a level still above the fasting pressure. In the bottom graph very little change occurred in the pressure after the meal. A slight elevation to a plateau was maintained for the first hour and was followed by a slight, gradual fall for the next 40 minutes and, finally, a slight elevation for the remaining period of observation. The four graphs of common bile duct pressures show the variability of response in this system; in only one of the graphs was there any similarity between the pattern of pressure changes in the common bile duct and that in the pancreatic duct.

Effect of Division of Muscle on the Pancreatic Duct Pressure

The results were obtained from two animals that worked satisfactorily after the procedures described. In both animals the fasting pancreatic duct pressures were markedly lowered compared with average pressures in the other animals. In Animal 6 the mean fasting level during three recordings was 30.6 mm. of water. In Animal 7 the mean fasting level after two recordings was 46 mm. of water. Following a meal the duct pressure rose to heights similar to those in animals in which the duodenal muscle had not been divided. In two separate tests in Animal 6 the maximal pressures were 92 and 123 mm. of water. In Animal 7 a maximal pressure of 168 was obtained following a meal. The maximal rise in pressure above the fasting level was of course higher than the average in the normal group. The mean maximal rise in Animal 6 was 76 mm. of water, with a range of 59 to 89, and in Animal 7 the maximal rise in pressure was 125 mm. of water. It appears that, although the fasting levels were lowered by dividing the muscle, the pressures following a meal were similar to those seen in animals without sphincterotomy.

Effect of Dividing Duodenal Muscle on the Common Bile Duct Pressure

The results here were obtained from only one animal. The effects were not so marked as with the pancreatic duct pressure. The mean fasting pressure of our three recordings was 30.3 mm. of water, which is perhaps significantly lower than that in the normal group except for Animal 1, which had a mean fasting level of 28.2 mm. of water.

Again, following a meal, the response was similar to that in the normal group. The maximal absolute pressures in two runs were 99 and 106 mm. of water, respectively.

COMMENT

Previous methods of estimating the pancreatic duct pressure involved blocking the duct with the recording cannula and gave a measure of the maximal secretory pressure of the pancreas. The upper limit of the pressure, according to Babkin,[9] must be a measure of the maximal pressure that the finer ducts can stand before fluid passes in a retrograde fashion into the pancreatic substance. The pressures observed in the pancreatic duct during the present studies were considerably lower than those hitherto described. The mean fasting pressure in a group of five dogs was 91 mm. of water. The maximal pressure observed following a normal meal was 198 mm. of water, and after a meal with double the normal bulk a pressure of 243 mm. of water was recorded. Previous work on pancreatic duct pressures has shown that, after stimulation of the gland and occlusion of the duct by a cannula, the pressure is around 300 mm. of water. Some of the work, however, was done on anesthetized dogs, the gland being stimulated with secretin or duodenal extract. When the animals were unanesthetized and pressures were taken after meals, the ducts were occluded by the cannula and the pressures observed must be maximal, and therefore they are not neces-

sarily indicative of those normally present in the ducts. The pressures observed by the present method are considerably lower than those previously described because the pancreatic juice is able to enter the duodenum through its normal channel during the time of observation of the pressures.

Harms [7] found a maximal pressure of 427 mm. of water, and Herring and Simpson [4] observed pressures of 318 mm. of water in anesthetized dogs after an injection of duodenal extract. Zucker and associates [3] found a maximal fasting pressure of 340 mm. of water and a maximal postprandial pressure of 390 mm. of water. Jordan and Hallenbeck [5] recorded maximal secretory pressures ranging from 340 to 440 mm. of water followed by a slow fall to levels 100 to 200 mm. lower than the maximal pressure recorded. In so far as the ductal system is not subjected to any resistance other than normal, the pressures observed by the present method are more likely to be those normally occurring within the ducts.

In the investigation of common bile duct pressures in the dog, previous workers have been concerned to a large extent with the mechanism of the assumed sphincter at the duodenal end of the duct. Mann [10] (1919) queried the presence of a true sphincteral mechanism in the dog and found that fluid would pass from the common bile duct into the duodenum at a pressure of 75 to 100 mm. of water. Elman and McMaster [6] (1926) stated that the sphincteral mechanism present can stop the passage of bile into the duodenum with pressures lower than 150 mm. of water. They found that during fasting or after a carbohydrate meal the resistance to the entry of bile into the duodenum was as high as 300 mm. of water. Lueth [11] (1931) found pressures from 65 to 590 mm. of water to be necessary to cause bile to pass into the duodenum. Average pressures were 110 to 135 mm. of water. Lueth was convinced of the presence of a sphincteral mechanism.

In the present studies it was found that in a group of five dogs the average fasting pressure in the common bile duct was 48 mm. of water. The lowest fasting pressure was 3 mm. of water, and the highest was 94 mm. of water. After various types of meals maximal pressures obtained in the series ranged from 86 to 178 mm. of water. During the periods of observation after meals, bile was invariably present in the duodenal contents, as seen in the transparent duodenal tube. We must conclude, therefore, that the pressure necessary for passage of bile into the duodenum must lie within this range, and the results agree with those suggested by Mann (1919), who, as previously stated, found the range to be from 75 to 100 mm. of water.

The pressures in the common bile duct were always lower than those in the pancreatic duct during a fasting period, and this relationship existed in the majority of cases after meals. Apart from one animal, in the cases in which the common bile duct pressure exceeded that in the pancreatic duct the phenomenon was found in the early period after a meal. The steep gradient of the pressure at this period is probably caused by the sudden, powerful contraction of the gall bladder and the forcing of a large volume of bile into the ductal system.

Division of the duodenal muscle over the common bile duct did not produce any startling or convincing results, though it was felt that the pressures during the fasting period were lowered. Following a meal the effect was not apparent and the pressures were similar to those in normal dogs. The fasting pressure in the pancreatic duct after division of the duodenal muscle over the duct was certainly lowered to about a third of the average normal pressure, but following a meal the pressures were again similar to those in normal dogs. Any attempt at explaining this is conjectural, but it is reasonable to suggest that during the fasting period the duodenal wall is relaxed and the intraluminal pressure is low, so that the pancreatic flow is uninterrupted, but that during increased tone and peristalsis of the duodenal musculature after feeding the gap in the

muscle made at operation becomes negligible and once again the duct is compressed by the muscle of the duodenal wall.

SUMMARY

Pressures in the common and pancreatic ducts were measured in trained dogs by means of water manometers connected to flexible plastic tubes which led through the abdominal wall and through parenchyma and minor ducts of liver and pancreas to the main duct of each organ. The tubes did not occupy the lower or duodenal end of the ducts and therefore did not interfere with any sphincteral mechanisms in this region. A third manometer was connected to an intraduodenal tube.

Most striking was the finding that pressure in the pancreatic duct was nearly always much higher than that in the common bile duct. During fasting, pancreatic pressure was about twice that in the common bile duct. After a meal, whether standard, fat, carbohydrate, or protein, both pressures increased. Occasionally in most animals, and commonly in one, biliary tract pressure exceeded pancreatic tract pressure for a brief period after feeding; there was evidence that this was caused by emptying of the gall bladder. As might be expected, pressures in both ducts were lower than those commonly measured in experiments in which the ducts are obstructed.

In two animals in which "sphincterotomy" of the bile and pancreatic ducts was performed, the fasting pressures were considerably lowered in the pancreatic duct and slightly lowered in the common bile duct. After feeding, however, the pressures reached the same level as in animals with intact muscle.

REFERENCES

1. Herring, P. T., and Simpson, S.: The Pressure of Pancreatic Secretion, and the Mode of Absorption of Pancreatic Juice After Obstruction of the Main Ducts of the Pancreas, Quart. J. Exper. Physiol. **2**:99, 1909.

2. Elman, R., and McCaughan, J. M.: On the Collection of the Entire External Secretion of the Pancreas Under Sterile Conditions and the Fatal Effect of Total Loss of Pancreatic Juice, J. Exper. Med. **45**:561, 1927.

3. Zucker, T. F.; Newburger, P. G., and Berg, B. N.: Further Studies on Continuous Secretion of the Pancreas, Proc. Soc. Exper. Biol. & Med. **29**:745, 1932.

4. Bennett, A. L., and Still, E. U.: A Study of the Relation of Pancreatic Duct Pressure to the Rate of Blood Flow Through the Pancreas, Am. J. Physiol. **106**:454, 1933.

5. Jordan, G. L., Jr., and Hallenbeck, G. A.: Effect of Increased Secretory Pressure on Canine Pancreatic Secretion, Am. J. Physiol. **170**:211, 1952.

6. Elman, R., and McMaster, P. D.: The Physiological Variations in Resistance to Bile Flow to the Intestine, J. Exper. Med. **44**:151, 1926.

7. Harms, E.: Über Druckmessungen im Gallen- und Pankreasgangsystem, Arch. klin. Chir. **147**:637, 1927.

8. Grindlay, J. H.; Eberle, J., and Walters, W.: Technique for External Drainage of the Biliary Tract Which Leaves Ducts Intact, A. M. A. Arch. Surg. **67**:289, 1953.

9. Babkin, B. P., cited by Thomas, J. E.: The External Secretion of the Pancreas, Springfield, Ill., Charles C Thomas, Publisher, 1950, p. 124.

10. Mann, F. C.: A Study of the Tonicity of the Sphincter at the Duodenal End of the Common Bile Duct, With Special Reference to Animals Without a Gall Bladder, J. Lab. & Clin. Med. **5**:107, 1919.

11. Lueth, H. C.: Studies on the Flow of Bile into the Duodenum and the Existence of a Sphincter of Oddi, Am. J. Physiol. **99**:237, 1931.

An Evaluation of Dilatation of the Sphincter of Oddi

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FRANK DAMAZO, M.D.
and
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The persistence of symptoms after biliary tract surgery is distressing to the surgeon and patient alike. The most frequent cause of persistence of symptoms is an incorrect or incomplete diagnosis. When gallstones are found on x-ray examination, it is usual to attribute all symptoms occurring in the upper right quadrant of the abdomen to their presence. It is of the utmost importance that patients with gall-bladder disease undergo a very thorough evaluation before concluding that the gall bladder is their only or even chief problem. Chronic pancreatitis with acute exacerbations; colon malfunction; renal, gastric, and duodenal disease; arthritis, and hiatus hernia are conditions well known to produce symptoms which may be erroneously attributed to the gall bladder.

Of particular interest has been a number of conditions occurring at the sphincter of Oddi. Anomalies in this region have been emphasized by Cole and Grove [1] as producing symptoms which have been attributed to the gall bladder. Functional disturbances of the sphincter of Oddi have been frequently suspected as a cause of postcholecystectomy syndrome, and the physiology and pharmacology of the sphincter apparatus have been thoroughly studied. Fibrosis of the sphincter has been found to be responsible for symptoms which are commonly associated with calculi in the biliary tract. Cattell and Colcock [2] recently reported 49 patients with this condition.

In an attempt to determine whether any pathological process is present at the sphincter of Oddi, it has been our practice for many years to pass graduated dilators into the duodenum whenever the common bile duct has been opened for any reason. It is obvious that this has not been done in patients requiring a simple cholecystectomy but in those instances in which additional pathology was seen or suspected. To determine the worthwhileness of this in obviating recurrent symptoms, we have studied the patients in which the procedure has been performed. This study forms the basis of this report.

METHODS AND TECHNIQUE

Mobilization of the duodenum is necessary for satisfactory palpation of the entire common duct. Incision of the lateral peritoneal reflection of the retroperitoneal portion (Fig. 1) permits rotation of the duodenum and head of the pancreas to the left and allows the lower end of the common duct and ampulla to be palpated between the thumb and index finger (Fig. 2). This maneuver also straightens out the common duct for easier or safer instrumentation.

Rather broad indications for opening the common duct should be used, since the procedure is accomplished today with a lower morbidity than ever before.

Once the common duct has been opened for one or more of the now well-established indications, the passage of graduated dilators through the sphincter should be a routine procedure, since it gives much pertinent information.

Forceful dilatation of the sphincter from above cannot be too strongly condemned. No attempt should be made to pass instruments through the sphincter of Oddi until the duodenum has been mobilized and the sphincter is held between the

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Figure 1.

thumb and forefinger of the left hand. The dilator is then inserted in the duct and passed down to the sphincter. With only gentle pressure from above on the dilator handle, the left hand which surrounds the sphincter is able by gentle counterpressure to roll the sphincter over the tip of the dilator. The amount of dilatation varies with the size of the common duct and the ease with which the dilators pass into the duodenum. If a 3-mm. dilator cannot be passed into the duodenum, fibrosis or stricture of the sphincter, or other pathologic condition, such as an impacted stone or carcinoma, is suspected and the transduodenal approach is employed so that the sphincter can be inspected and treated (Fig. 3). After the pathologic process is corrected, a long T-tube may be placed through it, as advised by Cattell.[3] When the sphincter is readily dilatable, an ordinary T-tube is inserted into the common duct and a cholangiogram is taken immediately or later, before the tube is removed.

RESULTS

During the period selected for study (1935-1952), it was found that the dilators had been used in 198 patients in whom the common duct had been opened and not used in 230 patients. These two groups were then compared as to hospital stay, complications, subsequent symptoms, morbidity, and mortality.

The amount of dilatation performed depended upon the size of the common duct, the ease with which the sphincter dilated, and other findings. It will be seen (Table 1) that in 13 patients a sphincterotomy was necessary because of a marked undilatable fibrosis. In addition two other jaundiced patients had a stricture of the sphincter

TABLE 1.—*Management of Sphincter of Oddi*

Procedure	Patients
Sphincterotomy	13
Dilated to 3 mm.	21
Dilated to 4 mm.	59
Dilated to 5 mm.	40
Dilated to 6 mm.	37
Dilated to 7-10 mm.	41
	211

which responded to dilatation and resulted in relief of the patient's symptoms. The days of hospitalization of choledochotomy patients were about the same in the dilated and nondilated groups (Table 2) showing that this procedure did not add to the morbidity. It must be remembered that this group of patients frequently had jaundice with severe liver impairment.

The follow-up study showed that 10 patients in whom the sphincter was not dilated were subsequently operated upon and stones were removed from the common duct (Table 3). None of the dilated group has required subsequent surgery, and only one has had

Figure 2.

TABLE 2.—*Days in Hospital after Choledochotomy*

	Sphincter Dilated	Not Dilated
Under 10 days	3	3
10-15 days	42	45
16-20 days	50	65
21-25 days	36	48
26-30 days	34	36
Over 30 days	33	32

symptoms which might be referable to the common duct. This patient is listed as having biliary colic and is still being observed and studied.

TABLE 3.—*Causes of Immediate and Late Morbidity*

	198 Patients Sphincter Dilated	230 Patients Not Dilated
Postoperative		
Residual or reformed stone	0	10
Pancreatitis	1	1
Biliary colic	1	4
Biliary fistula (temporary)	7	6
Preoperative and postoperative		
Cholangitis	4	5
Hepatic impairment	6	5

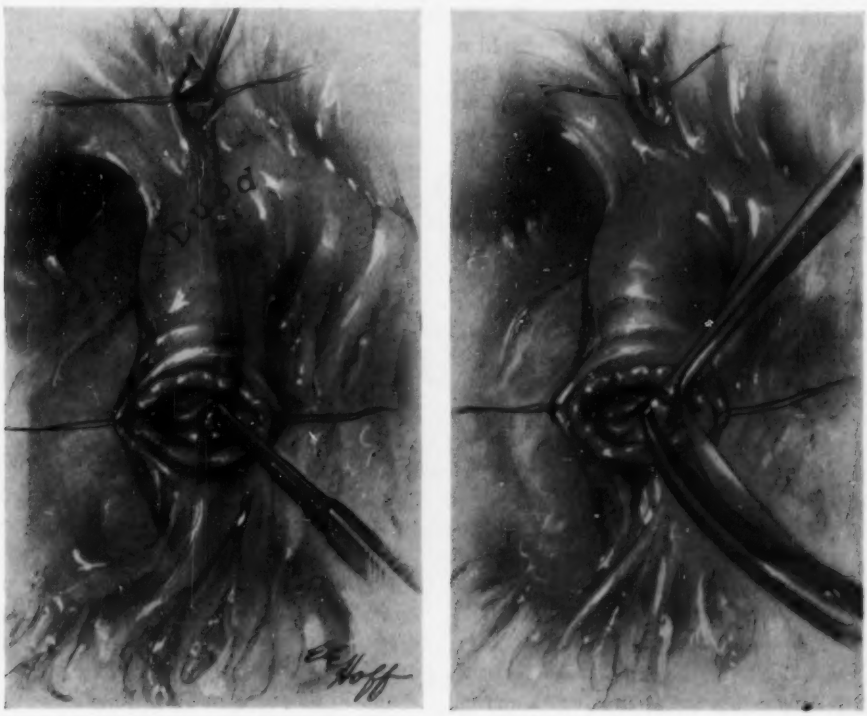
The cholangitis and liver impairment usually present in most of these patients was improved postoperatively.

TABLE 4.—*Causes of Mortality after Choledochotomy*

	198 Patients Sphincter Dilated	230 Patients Not Dilated
Obstructive jaundice	0	2
Acute pancreatitis	1	0
Pulmonary embolus	1	1
Duodenal fistula	0	1
Hepatic failure and uremia	2	1
Septicaemia	0	1
Hemorrhage (all prior to 1937)	2	2
Peritonitis (spontaneous choledochoduodenal fistula pre-op.)	1	0
	7	8

The causes and percent of mortality in the dilated and nondilated group was approximately the same (Table 4). However, two patients in the nondilated group were found to have impacted stones which should have been detected and removed. These 2 patients, in addition to the 10 other nondilated cases

Figure 3.



mentioned above, in which stones were subsequently removed, justify our thesis that the dilators should be used whenever the common duct is opened.

COMMENT

Stasis and infection in varying proportions have long been accepted as the primary cause of biliary calculi. The causes of the stasis may be several, but one of great importance obviously is functional—organic stricture of the sphincter of Oddi. This condition, in addition to being a possible etiological factor in calculi may be responsible for many of the symptoms usually attributed to the gall bladder. When a pathologic condition of the sphincter is the cause of symptoms, the patient will obviously not be relieved by a simple cholecystectomy. It is possible to have the typical symptoms of chronic gall-bladder disease in functional disturbance of the sphincter.

The possibility of overlooking a stone when the common duct is explored is well known to every surgeon. The overlooked stone may be in any part of the ductal system but is most commonly just above the sphincter. The practice of introducing dilators into the duodenum and carefully palpating along the course of the dilator will often reveal stones that may otherwise be overlooked. Furthermore, a dilated sphincter should allow the passage of any debris and small calculi, which may remain even after a thorough washing out of the common duct.

The indications for opening the common duct have been well established by Glenn,[4] Ravdin,[5] Waugh,[6] and others.[7] We feel that rather broad indications for choledochotomy should be used but that it should not be regarded as a routine procedure. However, once the decision to open the duct has been made, it should be explored in a well planned and thorough manner; nothing should be left undone that will help locate and remove any stones that are present and also rule out stenosis and fibrosis of the sphincter of Oddi as a cause of the symptoms.

The sphincter of Oddi must not be needlessly damaged, since it provides a normal barrier against ascending infection. This fact has been well recognized by many who advise end-to-end repair of a common duct stricture whenever possible. However, cholangitis is also known to develop when there is obstruction to the flow of bile, and this fibrosis of the sphincter may be a factor in the so-called re-formed stones that occur within the duct. Examination of bile which has been aspirated from the common duct may reveal sediment. This is frequently due to obstruction in patients with stones, but it may also be due to obstruction at the sphincter of Oddi. The diagnosis of cholangitis by this method is an indication for opening the common duct.

The relationship of pancreatitis to cholangitis and cholithiasis is well recognized. When, during a gall-bladder operation, induration is felt in the head of the pancreas, exploration of the duct with passage of the dilators into the duodenum is indicated to rule out obstruction at the ampulla and to establish adequate drainage of the common duct. This procedure will also assist in the detection of malignant conditions in the region of the ampulla.

The mortality and morbidity of common duct surgery have fallen in successive years with the introduction of vitamin K, chemotherapy, and antibiotics. In any discussion of common duct surgery, the degree of jaundice and of liver damage are of great importance and should be delineated in a discussion of morbidity and mortality figures. When the patient's condition is critical, simple decompression may be the procedure of choice, with definitive surgery being left for a more opportune time.[8]

CONCLUSIONS

Dilatation of the sphincter of Oddi by graduated dilators at the time of choledochostomy gives valuable information about the status of the sphincter.

Dilatation of the sphincter permits better drainage of the common bile duct and should permit debris and gravel to pass into the duodenum. Thus the number of residual stones in the ducts and liver should be less.

When carefully performed, dilatation of the sphincter does not add to morbidity or mortality over the usual choledochostomy procedure.

When dilatation of the sphincter is unsatisfactory, the duodenum should be opened and the sphincter dealt with under direct vision.

Graduated dilators should be passed through the sphincter of Oddi in every case in which the common bile duct is opened.

DISCUSSION

DR. BROCK E. BRUSH, Detroit: We realize that the passage of dilators through the sphincter of Oddi when the common bile duct has been opened is a procedure which has been used for a good number of years by many of you. We feel that so much additional information is obtained by doing this routinely that the procedure is worth reemphasizing.

We have been impressed with the fact that in the group of patients in which a choledochotomy was done but the sphincter not dilated, 10 patients had stones removed at a subsequent operation while none of those in the dilated group have as yet had stones removed at a later date.

The possibility of overlooking fibrosis, stricture, or tumor at the lower end of the common duct is greatly diminished when dilators are used. Induration in the head of the pancreas and jaundice are other absolute indications for obtaining accurate information about the sphincter area.

When carefully performed, dilatation of the sphincter does not add to the morbidity or mortality rates and may prevent a subsequent operation.

REFERENCES

1. Cole, W. H., and Grove, W. J.: Persistence of Symptoms Following Cholecystectomy with Special Reference to Anomalies of the Ampulla of Vater, Ann. Surg. **136**:73-82 (July) 1952.

2. Cattell, R. B., and Colcock, B. P.: Fibrosis of the Sphincter of Oddi, Ann. Surg. **137**:797-806 (June) 1953.

3. Cattell, R. B.: The Use of a Long T-Tube in Surgery of the Biliary Tract, S. Clin. North America **28**:659, (June) 1948.

4. Glenn, F.: Common Duct Exploration for Stones, Surg., Gynec. & Obst. **95**:431-438 (Oct.) 1952.

5. Ravdin, I. S.: Reconstruction of Common Bile Duct, Pennsylvania M. J. **53**:807-810 (Aug.) 1950.

6. Waugh, J. M.; Johnston, E. V., and Cain, J. C.: Surgical Aspects of Choledocholithiasis. J. A. M. A. **154**:734-738 (Feb. 27) 1954.

7. Allen, A. W.: Diagnosis and Treatment of Stones in Common Bile Duct, Surg., Gynec. & Obst. **62**:347-357 (Feb.) 1936.

8. Brush, B. E., and Zeller, F.: Indications for and Results of Gallbladder Surgery in Patients over 65 Years of Age, J. Am. Geriatric Soc. **1**:863-868 (Dec.) 1953.

Carcinoma of the Gall Bladder

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In 1777, Maximilian de Stoll [1] described carcinoma of the gall bladder. His first case was unusual in that it occurred in a left-sided gall bladder, in a patient with situs invertus. In the second case which he described the gall bladder was like cartilage, with ulceration of the liver and involvement of the mesentery. The lesions were found at autopsy examination.

Despite the infrequency of the disease, many reports have appeared. The difficulty in establishing a diagnosis, the bizarre symptoms, and the poor results of surgery have stimulated frequent studies of the disease. These reasons prompted our review of 50 patients having carcinoma of the gall bladder from St. Luke's Hospital, Chicago.

INCIDENCE

Carcinoma of the gall bladder is reported as occurring in 0.71% to 8.5% of all surgical gall-bladder specimens.* It is found in 0.27% to 0.34% of all autopsy examinations.† Approximately 4.5% of all malignancy deaths are due to carcinoma of the gall bladder.[5] Lam [18] states that there are about 6500 deaths annually from carcinoma of the gall bladder in the United States. With the constant increase in the older age group in this country and the high incidence of calculus cholecystitis in the older patient,[19] we may expect to see an increase in the number of patients developing carcinoma of the gall bladder.

AGE

The majority of the carcinomas of the gall bladder are in patients over 50 years of age. Thirty-three of our 50 patients, or 70%, were over 60 years of age. The oldest patient was 83 years of age; the youngest was 32 years of age. The average age of the patients was 65 years. Biering [20] reported a girl of 13 having carcinoma of the gall bladder.

SEX

Thirty-four patients were females, and 16 were males.

ETIOLOGY

Various theories have been presented as to the cause of the disease. These include irritation from stones, the carcinogenic action of bile acids and salts, and malignant degeneration of papilloma of the gall-bladder wall. Most of the gall bladders having carcinoma contain stones. It is paradoxical, however, that our only five-year survival was in a patient having a noncalculus gall bladder. Experimental introduction of gallstones and other foreign bodies into the gall bladders of animals will not produce carcinoma consistently.

Papillomas of the gall-bladder wall are found in approximately 8% of surgically removed gall bladders.[21] Rarely, however, can malignant degeneration be attributed to a papilloma of the gall-bladder wall.[22]

PATHOLOGY

At the postmortem examination of patients dying of carcinoma of the gall bladder we have been impressed with the diffuse and widespread metastases, confined to the abdomen. Distant metastases were noted in-

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* References 2 to 17.

† References 6, 9, and 12.

Fig. 1.—Liver metastases from carcinoma of the gall bladder.

frequently. The organs involved are contiguous structures and regional lymph nodes. The liver (Fig. 1), bile ducts, duodenum, omentum, colon, and biliary and periaortic nodes (Fig. 2) are the sites involved most frequently.

The mode of spread is understood when the lymphatic drainage of the area is studied. Rouvière,[23] the French anatomist, outlined the diffuse lymphatic drainage of the gall bladder by injection experiments and has beautifully illustrated their distribution (Fig. 3).

Carcinoma of the gall bladder can be classified on a pathological basis into four cell types:

1. Scirrhous, or infiltrating adenocarcinoma is the commonest type, comprising 70% of all cases. The tumor is highly malignant and invasive (Figs. 4 and 5).

2. Papillary or villous carcinoma is found in about 20% of cases. Ulceration is associated frequently with this type of tumor (Figs. 6 and 7).

3. Colloid or mucoid carcinoma is present in about 8% of cases (Figs. 8 and 9). The gall bladder ranks next to the stomach as the cause of gelatinous or mucoid carcinoma of the peritoneum.

4. Squamous cell carcinoma is present in about 2% of cases (Figs. 10 and 11). The origin of this tumor has been the subject of considerable discussion.‡ These tumors arise, in all probability, from the basal layer of cells in the mucosa and are analogous to the cells in the basal layers of the skin.

SIGNS AND SYMPTOMS

No consistent pattern of signs and symptoms is present. An early diagnosis is almost

‡ References 24 and 25.

Fig. 2.—Periaortic metastases from carcinoma of the gall bladder.

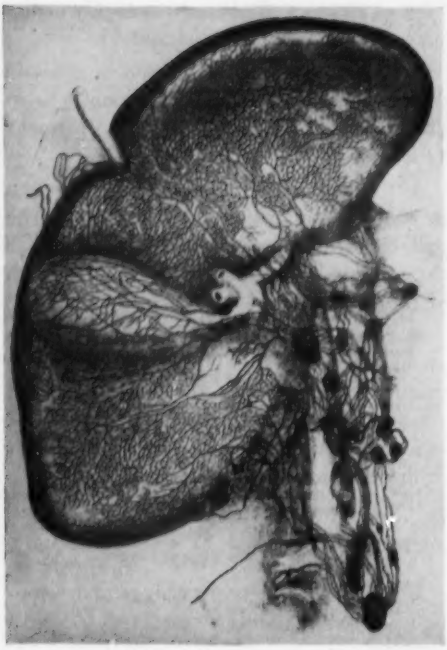


Fig. 3.—Lymphatic drainage of the gall bladder area. Reproduced from Rouière, H.: Anatomy of the Human Lymphatics, Translated by M. J. Tobias, Edwards Bros., Inc., Ann Arbor, Mich., 1938, Fig. 98, p. 199.

Fig. 4.—Scirrhous carcinoma of the gall bladder.

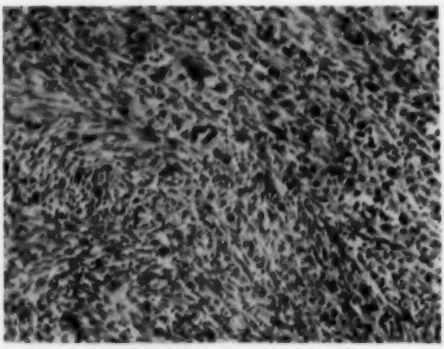


Fig. 5.—Photomicrograph of scirrhous carcinoma of the gall bladder (low power).

Fig. 6.—Papillary carcinoma of the gall bladder.

Fig. 7.—Photomicrograph of papillary carcinoma of the gall bladder (low power).

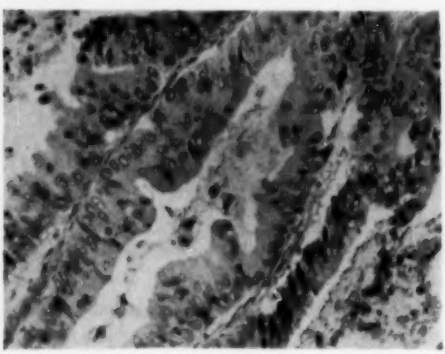
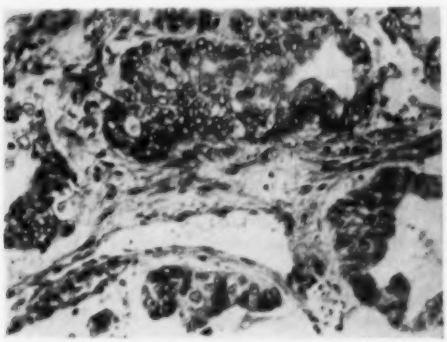


Fig. 8.—Pseudomucinous carcinoma of the gall bladder.

impossible. The only clue as to a possible carcinoma of the gall bladder is a change in the character of the patient's symptoms when compared with previous gall-bladder symptoms. One-half of our 50 patients gave a history of gall-bladder disease. Eleven patients had undergone previous cholecystostomy, with removal of stones.

Constant and severe pain was present in 35 patients. The pain was located in the right upper quadrant and epigastrium in most instances. Such pain usually indicates

Fig. 9.—Photomicrograph of pseudomucinous carcinoma of the gall bladder (low power).



extension of the carcinoma beyond the confines of the gall bladder.[20]

Weight loss, with increasing weakness, was one of the most consistent findings. It was present in 30 of the 50 patients.

Jaundice was present in 25 patients at some time in the course of the disease. It was produced by pressure of the tumor, inflammatory edema, and swelling with obstruction or to metastatic involvement. The jaundice was painless in 10 patients. Painless jaundice is ascribed usually to obstruction of the distal common duct by carcinoma of the ampulla or head of the pancreas.

Fig. 10.—Squamous cell carcinoma of the gall bladder.

We were surprised to learn that anemia was present so infrequently in this disease, even though there were widespread intra-abdominal metastases. It was present in only 14 of the 50 patients.

Acute cholecystitis, due to blockage of the cystic duct by stone or tumor tissue, was observed frequently (Fig. 12). In performing cholecystostomy, great care must be taken to perform a biopsy on any suggestive tumor area in the gall-bladder wall. This is sometimes very difficult to distinguish from inflammatory tissue. Even if biopsy is done, one must be certain to include the lesion. Two of our patients illustrate this point.

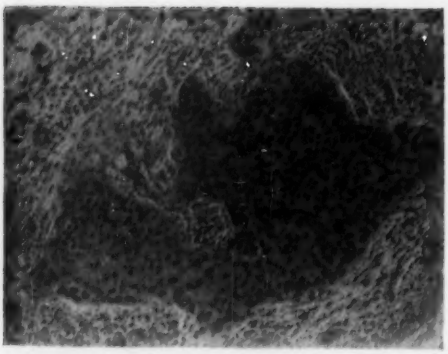


Fig. 11.—Photomicrograph of squamous cell carcinoma of the gall bladder (low power).

Case 1.—A 72-year-old white woman was operated upon for acute cholecystitis. Cholecystostomy and removal of a stone with biopsy of gall-bladder wall were done. The pathologist reported exudative cholecystitis. The symptoms persisted, and subsequent exploration revealed carcinoma of the gall bladder with metastases producing duodenal obstruction (Fig. 13).

Case 2.—A 50-year-old white man was operated upon for acute cholecystitis. A necrotic, perforated gall bladder with stones and pericholecystic abscess was found. The gall bladder was drained, and a section of the gall bladder wall was taken for microscopic examination. The tissue was reported as showing acute necrotic cholecystitis. Four months later silent jaundice developed. Exploration revealed carcinoma of the gall bladder with metastases.

Fig. 12.—Carcinoma and stone obstructing the neck of the gall bladder, producing acute cholecystitis.

In carcinoma of the gall bladder, the diagnosis is made rarely before operation. Four correct preoperative diagnoses were made in our 50 patients.

The confusing nature of the disease is well illustrated by the wide variety of preoperative diagnosis in our patients (Table 1).

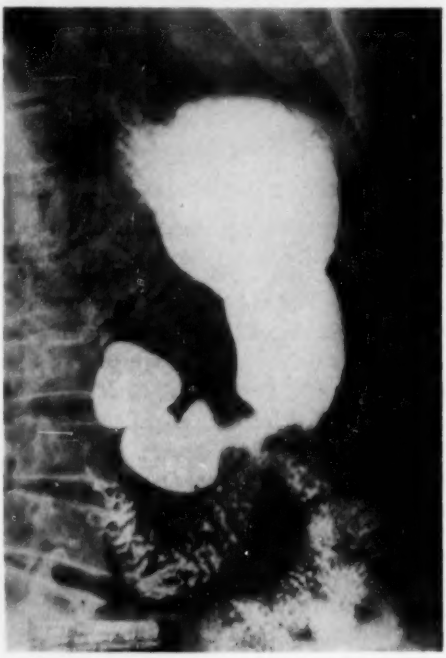


Fig. 13.—X-ray, with barium, showing obstruction of the duodenum caused by carcinoma of the gall bladder with metastases.

Table 1.—*Clinical Diagnoses in Cases of Carcinoma of the Gall Bladder*

Acute cholecystitis
Obstruction of the duodenum, shown by x-ray
Obstruction of the hepatic flexure of the colon, shown by x-ray
Carcinoma of the head of the pancreas
Carcinoma of the cecum, shown by x-ray
Ampullary carcinoma of the bile duct
Common duct stone
Carcinoma of the stomach with metastases
Cirrhosis of the liver
Generalized carcinomatosis
Suppurative cholangitis
Acute small bowel obstruction

COMMENT

Few tumors, if any, carry a worse prognosis than carcinoma of the gall bladder (Table 2). Five of our patients had no surgery. Twenty-six patients had exploration and biopsy, and 19 patients had cholecystectomy. Twenty-seven of the 50 patients died while in the hospital. Cholecystectomy, with any hope of cure, is possible in only a few patients with carcinoma of the gall bladder and then only in those tumors confined to the mucosa of the gall bladder. A deliberate attempt to resect the carcinoma, after invasion of the liver, bowel, or other neighboring structures, offers little hope of cure. In 1947, Sheinfeld [27] collected 36 cases of extensive resection of the gall bladder and contiguous structures. The operative mortality was 13.8%. Early recurrence developed in 38.8%. Since that time other authors have reported wide resections.§ Booher and Pack [32] reported a five-year cure in such a case. The following case report illustrates the usual futility of wide resection.

TABLE 2.—*Survivals in Reported Series of Cases in the Literature*

Author	Total Cases	Survivals
Quinn, M. (1908) [33]	57	1 (4 yr. 6 mo.)
Quenu, E. (1909) [34]	93	1 (4½ yr.)
	..	2 (3 yr.)
	..	2 (2 yr.)
	..	1 (1 yr.)
Smithies, F. (1919) [13]	23	2 (4 yr.)
Magown, J. A. H., and Renshaw, K. (1921) [35]	84	3 (5 yr.)
Gibson, C. L. (1926) [36]	15	None
Webber, I. M. (1927) [37]	20	1 (5 yr.)
Shelley, H. J., and Ross, L. I. (1932) [38]	19	1 (6½ yr.)
Rhodes, R. L., and Greenblatt, R. B. (1937) [39]	24	2 (5 yr.)
Cooper, W. A. (1937) [8]	45	1 (5 yr.)
Lam, C. R. (1940) [18]	34	1 (5 yr.)
Lichtenstein, G. M., and Tannenbaum, W. (1940) [40]	75	1 (5 yr.)
Warren, R., and Baleh, F. G., Jr. (1940) [15]	35	1 (12 yr.)
	..	1 (2½ yr.)
Vadheim, J. L.; Gray, H. K., and Dockerty, M. B. (1944) [20]	54	8 (5 yr.)
Finney, J. M. T., and Johnson, M. L. (1945) [41]	18	(10½, 16½, and 25 mo.)
Benjamin, E. G. (1948) [42]	70	None
Sainburg, F. P., and Garlock, J. H. (1948) [43]	75	1 (13 yr.)
Russell, P. W., and Brown, C. H. (1950) [7]	29	None
Danzis, M. (1951) [29]	32	1 (5 yr.)
Tragermann, L. J. (1953) [44]	173	1 (12 yr.)
Roberts, B. (1954) [45]	44	1 (11 yr.)
Glenn, F., and Hays, D. M. (1954) [46]	68	1 (7½ yr.)
	..	2 (4½ yr.)
	..	1 (1 yr.)
Strohl, E. L., and Diffenbaugh, W. G. (1954)	50	1 (5 yr.)

A 61-year-old white woman gave a history of repeated gall-bladder colics over a period of six years. X-ray examination two years prior to admission showed the presence of stones. The present course had its onset four weeks prior to admission. Severe pain was present in the right upper quadrant. There had been a 20 lb. (9 kg.) loss in weight. A palpable mass was present in the right upper quadrant. X-ray examination of the gastrointestinal tract revealed an extraluminal mass with pressure on the hepatic flexure of the colon (Fig. 14).

At operation March 19, 1953 (WGD) a carcinoma of the gall bladder was encountered, with involvement of the right lobe of the liver and the mesentery of the hepatic flexure of the colon. One node was palpable at the junction of the common and cystic ducts. Resection was accomplished, including the gall bladder, the greater portion of the right lobe of the liver, and the hepatic flexure of the colon (Figs. 13 and 14). Histological sections of the cut edge of the liver showed no evidence of carcinomatous extension beyond the line of resection. The patient was discharged from the hospital on the 16th postoperative day. Four months later a recurrent mass became palpable in the right upper quadrant. Jaundice developed. Death occurred three months later. Autopsy examination revealed extensive intra-abdominal carcinomatosis.

In our opinion, extensive resections will not greatly improve the survival rate in car-

§ References 28 to 31.

Fig. 14.—X-ray, with barium, showing metastatic involvement of the hepatic flexure of the colon, from carcinoma of the gall bladder.

cinoma of the gall bladder. Evarts Graham,[10] in 1931, stated that prophylactic cholecystectomy in calculus cholecystitis was justified because of the incidence of carcinoma of the gall bladder. In his series of cases carcinoma of the gall bladder was found in 8.5% of surgical gall-bladder specimens. Other clinics report a lesser incidence of carcinoma in calculus gall-bladder specimens. The average reported incidence is 2%. Graham was challenged vigorously on the grounds that the operative mortality for cholecystectomy would exceed the probability of carcinoma developing in a calculus gall bladder. Such reasoning is no longer valid. The operative mortality for elective cholecystectomy is now less than 1%.

In studying the complications of chronic calculus cholecystitis, one notes that there is a possibility of the development of acute cholecystitis in 16.2%, of common duct stones 12.8%, of pancreatitis in 3.8%, and of carcinoma in 2+ %.

Fig. 15.—Surgical specimen of carcinoma of the gall bladder with metastatic involvement of the right lobe of the liver and hepatic flexure of the colon.

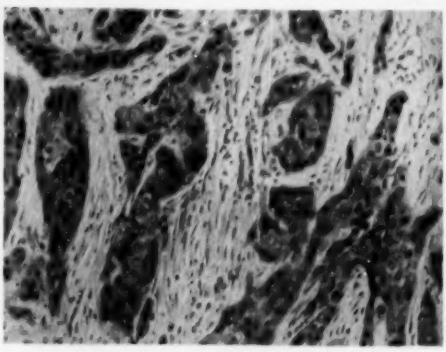


Fig. 16.—Photomicrograph of carcinoma of the gall bladder shown in Figure 15 (low power).

It may be argued that the incidence of carcinoma of the gall bladder does not, in itself, warrant routine cholecystectomy in calculus cholecystitis. Nevertheless, the combined incidence of complications of chronic calculus cholecystitis is justification for cholecystectomy in the early stages of the disease.

SUMMARY AND CONCLUSIONS

A series of 50 consecutive carcinomas of the gall bladder is presented.

This tumor is found in 0.71% to 8.5% of all surgical gall-bladder specimens. About 6500 deaths occur annually in the United States from this disease. More will develop as the life span of man increases.

Most gall bladders having carcinoma contain stones.

The bizarre symptoms preclude early diagnosis.

Surgical results are poor except in the early Grade I tumors, limited to the mucosa.

The incidence of carcinoma of the gall bladder may not in itself justify routine cholecystectomy.

The combined incidence of complications of calculus cholecystitis is justification for cholecystectomy, once calculus cholecystitis is diagnosed.

122 S. Michigan Ave. (3).

DISCUSSION

DR. WALTMAN WALTERS, Rochester, Minn.: When Dr. Strohl asked me if I would discuss this paper after I had read it, I told him that my two cents' worth of discussion would be worth just about that much, because cancer of the gall bladder is a problem which, fortunately, confronts us infrequently but, unfortunately, yields very poor results on surgical treatment.

Yet even though at the time the situation perhaps appears to be hopeless, I think we ought to keep an open mind and see whether we can improve the results. I quite agree with Drs. Strohl and Diffenbaugh in this.

My own experience in the treatment of cancer of the gall bladder by cholecystectomy and associated partial hepatectomy is limited—and when I say partial hepatectomy I mean resection of a very small portion of the liver, probably too small. Removing a wedge-shaped portion of the right lobe of the liver adjacent to the gall bladder, as far as I have been able to determine, has not been too helpful in prolonging the patient's life.

Recently I heard an interesting presentation on this subject at the Interstate Postgraduate Assembly, when one of our friends from the East described a case in which partial hepatectomy with removal of a larger portion of the liver and cholecystectomy had given the patient a five-year cure. However, you will recall that Dr. Strohl, from less extensive partial hepatectomy, also reported a five-year survival in one case in his series.

At this point I wish to bring to your attention the case of a woman 80 years of age who had a small obstructive (Parker) papillary carcinoma of the left intrahepatic duct. I scooped it out. One end of a T-tube was placed beyond it. When the T-tube was removed, recurrence of the biliary obstruction took place. When the biliary obstruction returned, seemingly from recurrence of the tumor, because her liver had also enlarged, to comfort her I suggested that she have some x-ray therapy, without any hope of accomplishment on my part.

Much to my amazement, in a period of six to eight weeks after the x-ray therapy her jaundice subsided, and she has had no evidence of biliary obstruction since. In a recent letter from her—months after the x-ray therapy was given—she said that she is still free of biliary obstruction and in good health except for some backache. Whether that is spontaneous or not (and I have no proof that she had a recurrence), I do not know. The x-ray accomplishment, if it was an x-ray accomplishment, seems astonishing and was unexpected.

I think that what we might do in some of the cases of carcinoma of the gall bladder is a wider resection of the liver and perhaps give intensive postoperative x-ray therapy to the region and the regional lymph nodes.

In my experience, when I have been able to suspect cancer of the gall bladder during the course of the examination, the patient has all of the symptoms which Dr. Strohl so well displayed in his table. The loss of weight usually is quite disproportionate to the loss sustained by a patient with recurring cholecystitis. Usually also the patient has a high sedimentation rate. Frequently the gall bladder is palpable.

In consideration of how to prevent carcinoma of the gall bladder, do not forget that practically all of Dr. Strohl's patients had gallstones and practically all of yours and all of those I have operated on have had stones. Certainly this alone is ample justification for cholecystectomy in all patients with gallstones, providing there is no contraindication to a surgical procedure—and of course there are many other reasons also for recommending cholecystectomy in such cases.

Since the risk of cholecystectomy is so low, 0.5% to 1%, I think we ought to impress on our medical colleagues that it is fallacious thinking to treat persons with gallstones with diet and saline laxatives.

DR. GUY V. PONTIUS, Chicago: I agree with Dr. Walters that Dr. Strohl has left us very little to talk about. I would like to call your attention, however, to the high incidence of pain in patients with carcinoma of the gall bladder and to elaborate a bit on the type of pain.

It is not the colic pain that we see with cholelithiasis. It is a constant, boring, unremitting, right upper quadrant type of pain. If we keep that in mind it may lead us at times to suspect preoperatively what we are dealing with.

My experience with carcinoma of the gall bladder was during my internship when on the service of Dr. Albert E. Halsted, when he brought in a very dear friend of his in an acute episode of cholecystitis. In those days it was quite customary to wait until the inflammatory reaction had completely subsided, which was usually from one to

two months. He did not wait with this patient, and I wondered why. He opened the abdomen and immediately said, "This is a carcinoma of the gall bladder."

Later he told me that the reason he did not wait was because, in spite of the subsiding of the inflammatory reaction, this persistent, boring type of pain increased. I believe, if we analyze our problems in acute cholecystitis, that mere fact may lead us to suspect that we are dealing with a malignant gall bladder.

The other point I would like to raise in regard to the pain of carcinoma of the gall bladder is exemplified by the one five-year cure which Dr. Strohl has presented. We have always considered that the pain indicated that the disease had advanced beyond the gall-bladder wall. The fact that this patient is alive and free from evidence of recurrence five years after operation would indicate that this lesion was confined to the gall bladder. However, cholographic studies had demonstrated a normally functioning gall bladder without stones but with a possible deformity. This patient complained of the usual right upper quadrant persistent pain with increasing severity of some two months' duration. No other evidence could be found to explain this pain; therefore, exploration was carried out. The patient was immediately relieved of his pain and has remained well to this date.

Perhaps we must reevaluate the mechanism and significance of this type of pain.

DR. EVERETT P. COLEMAN, Canton, Ill.: I would like to reemphasize the importance of cholecystectomy whenever stones are present. The mortality rate reported so far is very high.

I would like to quote a much better record than that. I have a 50% survival record in a large series of two cases. [laughter] This emphasizes the importance of early diagnosis.

My first one was a very obese woman with a strangulated umbilical hernia. At the time of repairing the hernia, exploration was done, and she was found to have what appeared to be an empyema of the gall bladder. The incision was enlarged, and the gall bladder was removed. The pathologist's report was "carcinoma." The patient survived about 18 months.

The second case was a woman with a large uterine fibroid. A hysterectomy was done. The routine exploration of the abdomen revealed one stone in the gall bladder. She had had one colic about two years prior to that. Ten days later the gall bladder was removed. It appeared to be a rather normal-appearing gall bladder with one stone, but on the upper portion of the gall bladder, opposite the liver portion, there was a tiny nodule. The pathologist reported that as being malignant. The patient is still living after almost 10 years.

My only diagnostic criteria are to find stones in the gall bladder and then to remove them. Once in a while, as I did, you may catch an early carcinoma, and the patient may recover.

Seeing this slide showing the lymphatic supply, I wonder yet how that one case did survive, and even Dr. Strohl's one case.

REFERENCES

1. de Stoll, M.: Pars Prima Rationis Mendendi, in Nosocomio practico Vindobonensi, Vienna, A. Bernard, 1777, p. 290.

2. Gray, H. K., and Sharpe, W. S.: Carcinoma of the Gallbladder, Extrahepatic Ducts and Major Duodenal Papilla, S. Clin. North America **21**: 1117-1127 (Aug.) 1941.

3. Judd, E. S., and Gray, H. K.: Carcinoma of the Gallbladder and Bile Ducts, Surg., Gynec. & Obst. **55**:308-315 (Sept.) 1932.

4. Mohardt, J. H.: Carcinoma of the Gallbladder: Collective Review, Surg., Gynec. & Obst. **69**: 440-451 (Nov.) 1939.

5. Arminski, T. C.: Primary Carcinoma of the Gallbladder, Cancer **2**:379-398 (May) 1949.

6. Jones, C. J.: Carcinoma of the Gallbladder: Clinical and Pathological Analysis of 50 Cases, Ann. Surg. **132**:110-120 (July) 1950.

7. Russell, P. W., and Brown, C. H.: Primary Carcinoma of the Gallbladder, Ann. Surg. **132**:121-128 (July) 1950.

8. Cooper, W. A.: Carcinoma of the Gallbladder, Arch. Surg. **35**:431-448 (Sept.) 1937.

9. Boyce, F. F., and McFetridge, E. M.: Carcinoma of the Gallbladder: Critique Based on 25 Cases from the Charity Hospital of New Orleans, Internat. Surg. Digest. **21**:67-69 (Feb.) 1936.

10. Graham, E. A.: Prevention of Carcinoma of the Gallbladder, Ann. Surg. **93**:317-322 (Jan.) 1931.

11. Jankelson, I. R.: Clinical Aspects of Primary Carcinoma of the Gallbladder, New England J. Med. **217**:85-88 (July 15) 1937.

12. Illingsworth, C. F. W.: Carcinoma of the Gallbladder, Brit. J. Surg. **23**:4-18 (July) 1935.

13. Smithies, F.: Primary Carcinoma of the Gallbladder, Am. J. M. Sc. **157**:67-74 (Jan.) 1919.

14. Deaver, J. B.: Carcinoma of the Gallbladder, M. Record **96**:47-49 (July 12) 1919.

15. Warren, R., and Balch, F. G., Jr.: Carcinoma of the Gallbladder: Etiological Role of Gallstones, Surgery **7**:657-666 (May) 1940.

16. Cole, W. H.: Factors in Prognosis and Mortality of Gallbladder Disease: Collective Review, Surg., Gynec. & Obst. **69**:40-46 (July) 1939.

17. Ulin, A. W.; Lichtenstein, I. L.; Garritano, A., and Fischer, S. M.: Carcinoma of the Gallbladder, Gastroenterology **15**:684-688 (Aug.) 1950.

18. Lam, C. R.: The Present Status of Carcinoma of the Gallbladder, Ann. Surg. **111**:403-410 (March) 1940.

19. Strohl, E. L., and Diffenbaugh, W. G.: Biliary Tract Surgery in the Aged Patient, Surg., Gynec. & Obst. **97**:467-470 (Oct.) 1953.

20. Biering, A.: Carcinoma of the Gallbladder in Girl of 13 Years, Nord. med. **29**:64-66, 1946.

21. Walters, W., and Snell, A. M.: Diseases of the Gallbladder and Bile Ducts, Philadelphia, W. B. Saunders Company, 1940.

22. Phillips, J. R.: Papilloma of the Gallbladder, Am. J. Surg. **21**:38-42 (July) 1933.

23. Rouvière, H.: Anatomy of the Human Lymphatic System, translated by M. J. Tobias, Ann Arbor, Mich., Edwards Brothers, Inc., 1938.

24. Krompecker, E.: Basal Cells, Metaplasia and Regeneration, Beitr. path. Anat. **72**:163, 1924.

25. Rabinovitch, J., and Kieffer, R. S.: Squamous Cell Carcinoma of Gallbladder, Surg., Gynec. & Obst. **52**:831-835 (April) 1951.

26. Vadheim, J. L.; Gray, H. K., and Dockerty, M. B.: Carcinoma of the Gallbladder, Am. J. Surg. **63**:173-180 (Feb.) 1944.

27. Sheinfeld, W.: Cholecystectomy and Partial Hepatectomy for Carcinoma with Local Liver Extension, Surgery **22**:48-58 (July) 1947.

28. Thorek, M.: Carcinoma of the Gallbladder, J. Internat. Coll. Surg. **10**:369-377 (July-Aug.) 1947.

29. Danzis, M.: Carcinoma of the Gallbladder: Report of 32 Cases, J. Mt. Sinai Hosp. **17**:467-477 (March-April) 1951.

30. Lemgruber, S.: Primary Malignant Tumor with Hepatic Metastases: Cholecystectomy and Partial Hepatectomy of Right Hepatic Lobe, Rev. brasil. cancerol. **2**:79-91 (March-Dec.) 1948.

31. Masse, L., and Dubourg, G.: Cancer of the Gallbladder, Cholecysto-Hepatectomy, Arch. mal. app. digest. **39**:261-267 (Feb.) 1950.

32. Booher, R. J., and Pack, G. T.: Report of a 5-Year Cure of Anaplastic Carcinoma of the Gallbladder with Metastases, Am. J. Surg. **78**:175-180 (Aug.) 1949.

33. Quinn, M.: Bull. et mém. Soc. chir. Paris **34**:215, 1908.

34. Quenu, E.: Cancer of the Biliary Ducts, Therapeutic Value of Palliative Operations, Postoperative Accidents, Rev. chir. Paris **29**:462-481, 1909.

35. Magown, J. A. H., and Renshaw, K.: Malignant Neoplasia of the Gallbladder, Ann. Surg. **74**:700-720 (Dec.) 1921.

36. Gibson, C. L.: Final Results in the Treatment of Malignant Disease: A 12-Year Follow-Up, Ann. Surg. **84**:158-173, 1926.

37. Webber, I. M.: Grades of Malignancy in Primary Carcinoma of the Gallbladder, Surg., Gynec. & Obst. **44**:756-760 (June) 1927.

38. Shelley, H. J., and Ross, L. I.: Primary Carcinoma of the Gallbladder: Study of 19 Cases, Arch. Surg. **25**:65-83 (July) 1932.

39. Rhodes, R. L., and Greenblatt, R. B.: Carcinoma of the Gallbladder: Study of 24 Cases in Georgia, South. M. J. **30**:315-318, 1937.

40. Lichtenstein, G. M., and Tannenbaum, W.: Carcinoma of the Gallbladder: Study of 75 Cases, Ann. Surg. **111**:411-415, 1940.

41. Finney, J. M. T., and Johnson, M. L.: Primary Carcinoma of the Gallbladder: An Additional Reason for Removal of the Calculus Gallbladder, Ann. Surg. **121**:425-434 (April) 1945.

42. Benjamin, E. G.: Carcinoma of the Gallbladder: An Analysis of 70 Cases, Minnesota Med. **31**:537-540 (May) 1948.

43. Sainburg, F. P., and Garlock, J. H.: Carcinoma of the Gallbladder: Report of 75 Cases, Surgery **23**:201-205 (Feb.) 1948.

44. Tragermann, L. J.: Primary Carcinoma of the Gallbladder: Review of 173 Cases, California Med. **78**:431-437 (May) 1953.

45. Roberts, B.: Primary Carcinoma of the Gallbladder, Surg., Gynec. & Obst. **98**:530-534 (May) 1954.

46. Glenn, F., and Hays, D. M.: The Scope of Radical Surgery in the Treatment of Malignant Tumors of the Extrahepatic Biliary Tract, Surg., Gynec. & Obst. **99**:529-541 (Nov.) 1954.

47. Strohl, E. L., and Diffenbaugh, W. G.: Acute Cholecystitis, S. Clin. North America **32**:63-69 (Feb.) 1952.

48. Strohl, E. L.; Diffenbaugh, W. G., and Guynn, V.: Symptoms of Common Duct Stones, A. M. A. Arch. Surg. **64**:788-793 (June) 1952.

Cholecystic Disease, Past and Present, Associated with Gastric Carcinoma

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and
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Palpation of the gall bladder at the time of laparotomy performed for intra-abdominal disease unrelated to the biliary tract has revealed the unexpected presence of gallstones in an impressive number of patients more than 40 years of age. The problem as to what course should be followed in these cases remains a serious one for the surgeon. Should the gall bladder which contains the "silent" stones be removed forthwith, in spite of the risk from a second major procedure? Or should cholecystectomy be postponed, thereby subjecting the patient to the chance of acute cholecystitis developing in the postoperative period, when the diagnosis might be masked by the effect of narcotics or the condition confused with other less serious complications? In other words, is watchful waiting justifiable?

PREVIOUS OBSERVATIONS

Answers to this question, which has just been stated in two ways, represent a wide variety of opinions. In 1948, Comfort, Gray, and Wilson [1] reported on a 10- to 20-year follow-up study of 112 patients with silent gallstones found in the course of abdominal operations unrelated to the biliary tract. These authors concluded that the surgical treatment for silent gallstones is elective but should not be postponed after symptoms, particularly colic, have appeared. The patient with silent gallstones, they said, could be told that he had one chance out of five that painful colic would occur within 10 to 20 years.

Clagett [2] stated his conviction that so-called innocent gallstones do not exist and that stones so designated should be removed unless other conditions are present which would make the risk greater than that from the cholecystic disease. To illustrate the danger of nonsurgical treatment he cited a series of 150 cases of cholecystic disease, observed at the Mayo Clinic, in which a nonfunctioning gall bladder was found and the patients had refused operation. Within two years, 27% of these patients had been operated on for serious complications, such as jaundice, pancreatitis, or perforated gall bladder.

Acute cholecystitis developing shortly after operations for disease unrelated to the biliary tract has been reported to occur more frequently than previously had been suspected. According to Glenn,[3] stagnation and concentration of bile in the gall bladder in the postoperative period are induced by withholding food for several days and by administration of drugs such as morphine, meperidine (Demerol), and codeine. On the ingestion of food there is, for the first time since water and food were withheld, an attempt on the part of the gall bladder to empty its viscid and concentrated bile into the common duct and duodenum. If a stone blocks the escape of this thick bile from the gall bladder, then the mechanism for obstructive cholecystitis is present and an acute attack may occur.

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Schwegman and DeMuth [4] reported 17 cases in which acute cholecystitis followed surgical operation for abdominal disease unrelated to the biliary tract, and, of these, gangrene or perforation was present in 8 (47%). These authors stated that the cholecystitis may go unrecognized since abdominal pain, nausea, and fever are accepted by surgeons as side-effects of the operation. They suggested that the gall bladder be palpated if it is accessible and if palpation will not increase the risk of operation; this would eliminate some of the uncertainties of diagnosis of this condition when it occurs in the postoperative period.

Relative to this, Mayo and Lee [5] reported that of 53 cases in which gallstones were found incidental to laparotomy for carcinoma of the right portion of the colon, and were left undisturbed, symptoms thought to be due to cholecystic disease were noted in 5 in the follow-up period. Cholecystectomy was performed subsequently in two additional cases in which stones were not palpable at the time of operation on the colon. The gall bladder in one of these two cases contained putty-like material; the other was subacutely inflamed and was without stones.

Robertson and Dochat [6] found, in a series of 16,936 necropsies performed at the Mayo Clinic, that the incidence of gallstones in males was about 12% and, in females, about 22%. Among women a sharp increase occurred between those of the age group 30 to 39 years (12%) and those of the age group 40 to 49 years (22%), and a significant increase occurred in each decade of life thereafter. Eliason and Stevens [7] stated that 15% of the people of the United States suffer from biliary disease and that after the age of 45 years the percentage rises to 30.

Whereas most of the publications on this subject have been based on data obtained at necropsy, reports have appeared which were based on palpation of the gall bladder at the time of operation. In 1911, W. J. Mayo [8] reported the incidence of gallstones in 1244 women operated on for uterine myomas as 7.1%. Truesdell [9] reported that gallstones incidental to other disease were present in 8.9% of 350 women who had undergone laparotomy for other conditions. Mayo and Lee [5] reported on 730 patients, aged 40 years or more, who had been subjected to surgical operation for carcinoma of the right portion of the colon. Of this group, 9.4% had gallstones that were palpated by the surgeon; in half of the cases, the gallstones had been unsuspected before operation.

PRESENT STUDY

The present study was undertaken to determine the status of the gall bladder, with special reference to the incidence of gallstones, in a group of patients who had intra-abdominal disease that was unrelated to the biliary tract. Those who had been operated on for malignant disease of the stomach were selected, since the surgical exposure for this condition usually makes visual inspection and palpation of the gall bladder almost a routine procedure. It was not our idea that a relationship between gallstones and malignant disease of the stomach might exist but, rather, that the proximity of the gall bladder and the stomach afforded an excellent opportunity for examination of the former while operating on the latter.

The records of 208 patients on which laparotomy was performed for malignant disease of the stomach during the year 1953 were examined. Since gallstones are less frequently seen in patients less than 40 years of age, these were excluded from the study; thus, 196 patients remained for analysis.

Most of the surgeons described the condition of the gall bladder. If they did not mention it, we considered that the gall bladder was found normal on examination. We realize, of course, that, in a few instances, palpation of the gall bladder may have been omitted for various reasons.

RESULTS

The status of the gall bladders of 196 patients, as determined from the past history, from roentgenograms, and from inspection and palpation of the gall bladder at the time of the surgical operation mentioned, is recorded in Table 1. In 162 cases (82.7%)

TABLE 1.—*Status of Gall Bladder: One Hundred Ninety-Six Cases*

Status	Cases	Per Cent of 196
No evidence of disease	162	82.7
Gallstones palpated at gastric operation	13	6.6
Previous operation for cholelithiasis	9	4.6
Previous cholecystectomy for unspecified condition	1	0.5
G. B. tense, distended, no stones palpable	2	1.0
G. B. thick-walled, adherent to duodenum, no stones palpable	2	1.0
G. B. contracted, covered with adhesions, no stones palpable	1	0.5
Gallstones detected on roentgenograms only	2	1.0
Nonfunctioning G. B., possibly stones	4	2.0

evidence of disease of the gall bladder could not be found. Of the 13 cases in which gallstones were palpated at the time of laparotomy, in 6 their presence had been unsuspected before operation. In nine of the cases (4.6%) previous operation for cholelithiasis had been performed, and in seven of these multiple stones had been found. In one case, the gall bladder had been removed, and no history was available regarding the presence or absence of stones. The average age of the patients at the time of this operation was 55.7 years. In three cases the cholecystectomy had preceded the gastric operation by less than six months, namely, three and one-half months, five months, and five months, respectively.

In one of the two cases in which the gall bladder was described as tense and distended, but stones could not be palpated, the surgeon thought the condition to be due to infiltration of the gastrohepatic ligament by gastric carcinoma. In the two cases in which gallstones seen on roentgenograms were not palpated at the time of operation, the entire peritoneal cavity was hopelessly involved with carcinoma. In the four cases in which roentgenograms gave evidence of the presence of a nonfunctioning gall bladder which possibly contained stones, the presence of stones could not be verified by the surgeon at laparotomy. Amplification concerning the other divisions of Table 1 is unnecessary.

The disposition of the gall bladder in the second, third, and fourth categories of Table 1 (13+9+1 case) is recorded in Table 2. In that Table, the classes have the following significance:

Class 1. Operation for cholecystic disease (not necessarily cholelithiasis in one case) had been done previous to the time of operation for gastric disease.

Class 2. The presence of gallstones had been suspected before the operation for gastric disease; the presence of stones was confirmed by palpation at the time of the gastric operation; the gastric operation and the gall-bladder operation, if any was done, were performed at the same laparotomy.

Class 3. The presence of gallstones had not been suspected before the operation for gastric disease; stones were found in the course of the gastric operation; the gastric operation and the gall-bladder operation, if any was done, were performed at the same laparotomy.

In most of the cases of Classes 2 and 3, in which the gall-bladder operation was postponed, six cases, the reason for the postponement was that, following prolonged and extensive gastric operation, risk would have been excessive.

In each of 60 cases symptoms had been sufficiently suggestive of cholecystic disease that a cholecystogram had been made. Of these, in 40 (66%) function of the gall bladder appeared to be normal, in 9 (15%) the organ was nonfunctioning, and in 11 (18.3%) function was either poor or it was normal in the presence of possible stones. In most of the 60 instances the symptoms which led to making the cholecystogram were not more indicative of gall-bladder disease than they were of malignant disease of the stomach.

Cholelithiasis was considered a finding incidental to the search for gastric carcinoma

TABLE 2.—*Disposition of Gall Bladder*

Class	Cases	Cholecystostomy	Cholecystectomy	No Gall Bladder Operation
1	10	1	9	0
2	7	1	2	4
3	6	1	3	2

in most instances. On the other hand, in one case, a carcinoma of the stomach was discovered on routine palpation of the abdominal organs at the time of laparotomy for cholelithiasis. Another patient had symptoms of gall-bladder disease and gave roentgenologic evidence of the presence of stones. On physical examination, however, an epigastric mass was palpated, and, at laparotomy, a large carcinoma was found on the anterior wall of the stomach.

The incidence of cholecystic disease associated with malignant disease of the stomach, according to sex, is represented in Table 3. Including from Table 1, the 13 cases in which gallstones were palpated at the time of gastric operation, the 10 cases (9+1) in which operation for cholecystic disease had preceded gastric operation, and the 2 cases in which gallstones were detected on roentgenograms only, 25 patients had or previously had had cholecystic disease, 24 of whom are known to have had cholelithiasis. Excluded are the cases in which the diagnosis of cholelithiasis could be questioned, such as those in which, in Table 1, the gall bladder is described as tense and distended, as thick-walled and adherent to the duodenum, as contracted and covered with adhesions, although it is possible that some of these gall bladders either contained stones or had contained them. Of patients included in the study, 8% of the men and 23% of the women had cholecystic disease.

The incidence of past and present cholelithiasis, according to age of the patients in decades is given in Table 4. It can be seen that, of the total number of patients in each decade, the percentage of those who had gallstones increased with age. Since there were only three patients of the 80 to 89 age group, the fact that none had gallstones is not significant.

TABLE 3.—*Incidence of Cholecystic Disease* According to Sex*

Sex	Total Cases	Incidence	
		Cases	Per Cent of Total in Same Horizontal Line
Male	131	10	8
Female	65	15	23
Total	196	25	13

* Stones in 24 cases.

TABLE 4.—*Incidence of Cholelithiasis According to Age: One Hundred Ninety-Six Patients*

Age, Yr.	Total Cases	Cholelithiasis	
		Cases	Per Cent of Cases in Same Decade
40-49	19	1	5.3
50-59	46	5	10.8
60-69	86	11	12.8
70-79	42	8	19.0
80-89	3	0	0.0

Gallstones were not found at operation, nor was there a past history of operation on the gall bladder, in any of the 12 patients who were excluded from this study because their age was less than 40 years.

Cholecystitis did not develop in the postoperative period in any of the six cases of Classes 2 and 3 (Table 2) in which stones were palpated but were not removed. In none of the seven cases of those two classes in which the gall bladder was treated surgically was it felt that morbidity was significantly increased by the operation.

SUMMARY AND COMMENT

In a series of 196 patients aged 40 years or more, who were operated on for malignant disease of the stomach, 13 (6.6%) were found by the surgeon to have palpable gallstones. Presence of these stones was unsuspected before operation in approximately half of the 13 cases. Ten patients (5.1%) gave a past history of previous operations on the gall bladder, most of them for multiple stones.

Of the 25 patients (13% of 196) who had, or previously had had, cholecystic disease, 10 were men (8% of the 131 men of the series) and 15 were women (23% of the 65 women of the series). These percentages are a little lower than those reported by Mayo and Lee [5] in their study of the incidence of gallstones discovered in the course of operation for carcinoma of the right portion of the colon. They found that gallstones existed

or had existed in 11.8% of the males and in 27.6% of the females.

The fact that 7 of 13 patients found to have gallstones (54%) were treated by cholecystectomy or cholecystostomy, performed at the time of laparotomy for gastric carcinoma, as compared to 31% in the series of Mayo and Lee,[5] may indicate a more aggressive approach to this problem in the last few years.

The gall bladder of every patient who undergoes laparotomy should be carefully examined, unless such examination is definitely contraindicated, and the condition of the organ should be noted on the report of operation. When gallstones are found associated with other conditions, there are no therapeutic rules which always will apply; usually, however, the presence of multiple stones, particularly if they are small, warrants operation more than if a large, solitary stone is present. If the wall of the gall bladder appears to be inflamed, the organ should be removed, but if the condition of the patient does not seem to justify this cholecystostomy may be preferred.

When a large, single, "silent" gallstone is found at laparotomy for a condition unrelated to the biliary tract, treatment is elective. If exposure is adequate and the condition of the patient will permit, probably it is better to perform cholecystectomy forthwith rather than to subject the patient to a second operation at a later date. However, frequently the lesion for which laparotomy originally was performed will indicate postponement of operation on the gall bladder. In this event, the patient should be told afterwards that a gallstone was found to be present, and the possibility of further trouble should be frankly discussed with him.

The development of acute cholecystitis in the postoperative period should be remembered as a possible complication if gallstones were found but were not removed.

Symptoms due to carcinoma of the stomach may simulate those of cholecystic disease. The presence of gallstones, however, does not necessarily indicate that they are the cause of the symptoms. Exploration of the stomach, colon, and other abdominal organs should be performed at the time of intended cholecystectomy, and, to repeat, the gall bladder should be palpated at the time of laparotomy for any condition.

REFERENCES

1. Comfort, M. W.; Gray, H. K., and Wilson, J. M.: The Silent Gallstone: A 10 to 20 Year Follow-Up Study of 112 Cases, Ann. Surg. **128**: 931, 1948.

2. Clagett, O. T.: Diseases of the Gallbladder: Diagnosis and Management, S. Clin. North America **25**:929, 1945.

3. Glenn, F.: Acute Cholecystitis Following the Surgical Treatment of Unrelated Disease, Ann. Surg. **126**:411, 1947.

4. Schwegman, C. W., and DeMuth, W. E., Jr.: Acute Cholecystitis Following Operation for Unrelated Disease, Surg., Gynec. & Obst. **97**:167, 1953.

5. Mayo, C. W., and Lee, M. J., Jr.: Present or Past Cholelithiasis Diagnosed at Laparotomy: Study of 730 Cases of Carcinoma of Right Portion of Colon, S. Clin. North America **31**:1217, 1951.

6. Robertson, H. E., and Dochat, G. R.: Pregnancy and Gallstones: Collective Review, Internat. Abstr. Surg. **78**:193, 1944.

7. Eliason, E. L., and Stevens, L. W.: Acute Cholecystitis, Surg., Gynec. & Obst. **78**:98, 1944.

8. Mayo, W. J.: "Innocent" Gall-Stones: A Myth, J. A. M. A. **56**:1021, 1911.

9. Truesdell, E. D.: Incidental Gall-Stones in Women, Ann. Surg. **98**:362, 1933.

Fig. *A*.—The Dodrill-GMR Heart together with photographs of patient's cardiac valves.

Scientific Exhibits

EXHIBIT OF THE MECHANICAL HEART

F. D. DODRILL, M.D.
DETROIT

THE FOLLOWING is an exhibit of the Dodrill-GMR Mechanical Heart. This was displayed at the 1953 session of the American Medical Association in New York and won the Hektoen Bronze Medal for original investigation. Since that time, it has been requested by, and given to, the Smithsonian Institution of Washington, D. C., for permanent preservation.

A close-up photograph of one side of the mechanical heart is seen in Figure 1. The opposite side is similarly constructed except that the pressures are different and the two sides of the mechanical heart are substitutes for the right and left ventricle.

From the Research Division of Harper Hospital.

The apparatus herein described was made by the Research Laboratories Division, General Motors Coroporation.

In Figure 2 there is seen the individual valve units. Blood is withdrawn into the cylinder which is made of glass and contains a finger cot which is alternately inflated and deflated, thereby drawing blood into the chamber and expelling it. Six valves may be used on either side. The alternating pressure and suction to the finger cot is activated by a small motor placed outside the operating room and is connected to the pump by rubber tubes.

Figure 3 is a diagrammatic illustration of a right-sided by-pass of the heart. Heparin is used to prevent clotting. Five milligrams per kilogram of body weight is used. Blood may be taken from the two venae cavae and passed through the mechanical pump and into the branch of the pulmonary artery in a retrograde manner. Or, the blood may be withdrawn from the right atrium itself and passed into the pulmonary artery. Inasmuch as the work of the right heart is then taken over by the mechanical device, it was possible to expose the pulmonary valve both in animals and in patients. By-pass of the right heart initiates the Bainbridge reflex; that is, when the right atrium is empty, hypotensive reflexes come into play which are acute in the dog. This may be prevented by the use of large doses of atropine.

In Figure 4 is seen the stenotic pulmonary valve in a 16-year-old patient. This young man had congenital pulmonary stenosis with a high pressure in his right ventricle, 190 mm. of mercury. The valvulotomy was done under direct vision. The Bainbridge reflex does not seem to be so acute in man.

Figure 5 shows a patient operated upon two years ago for pulmonary valve stenosis. The valve was exposed continuously for 25 minutes. The left heart and lungs continued to perform their functions. In order to do a right-sided by-pass, the cardiac septa must be intact.

Figure 6 is a diagrammatic illustration of a left-sided by-pass. The blood may be taken from the pulmonary veins or from the atrium itself and pumped directly into the aorta, thereby by-passing the left ventricle. The hypotensive reflex is not so acute or may be absent on the left side.

In dogs the left superior pulmonary veins may be cannulated, the cannula passing into the atrium so that the atrial blood is withdrawn and pumped into the aorta by way of the subclavian and femoral artery. A clamp then can be placed across the atrium between the suction cannula and the mitral valve. The lower portion of the atrium may then be opened, exposing the mitral valve. This is a very satisfactory experimental procedure. A large series of experiments have been performed with only an occasional death.

In Figure 7 is seen the open left atrium in a patient during which time the mitral valve was exposed and corrective surgery carried out. The mechanical heart maintained the systemic circulation during the time the left atrium was opened.

If one wished to by-pass the lungs as well as the entire heart, an oxygenator may be connected between the two sides of the mechanical heart.

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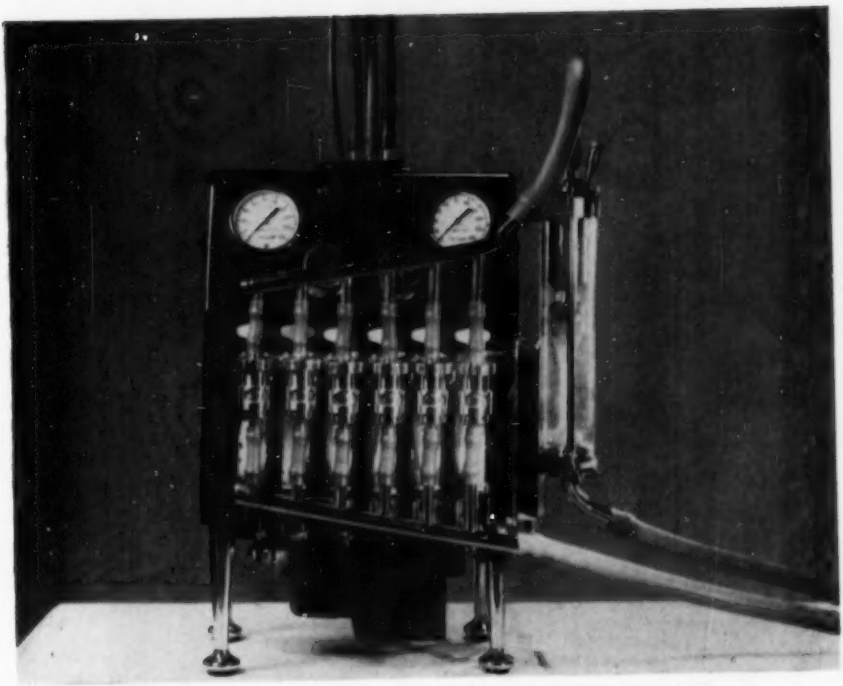


Fig. 1.—Close-up photograph of one side of the mechanical heart.

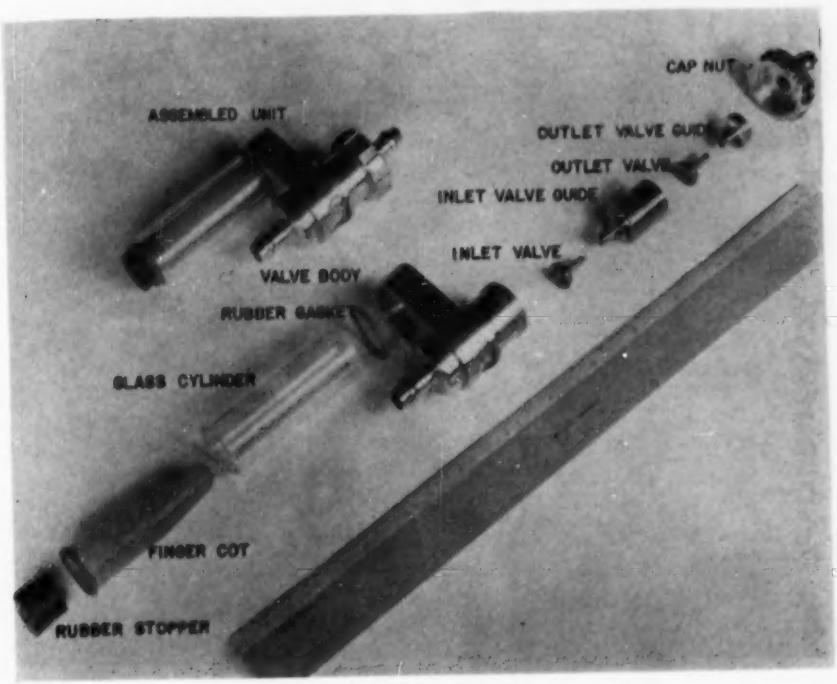


Fig. 2.—The valve units.

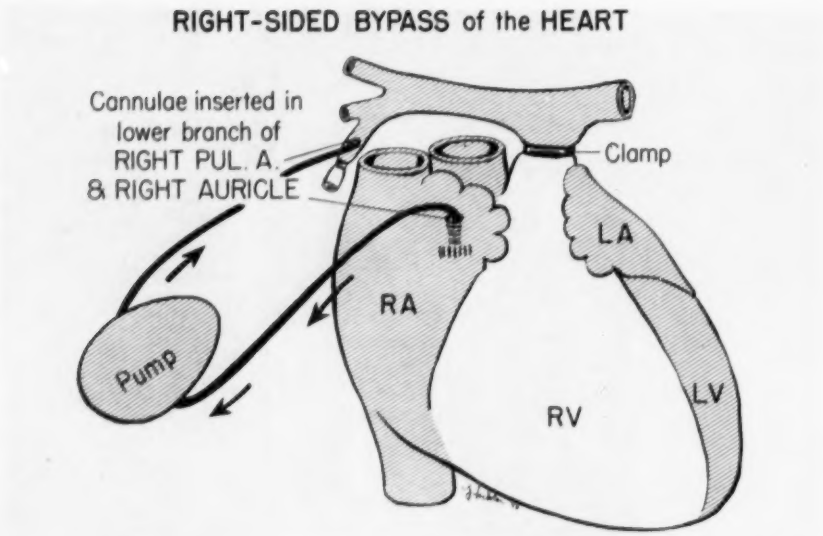


Fig. 3.—Diagrammatic illustration of a right-sided by-pass. The blood may be taken from the atrium or vena cava.

Fig. 4.—Stenotic pulmonary valve in a living patient.

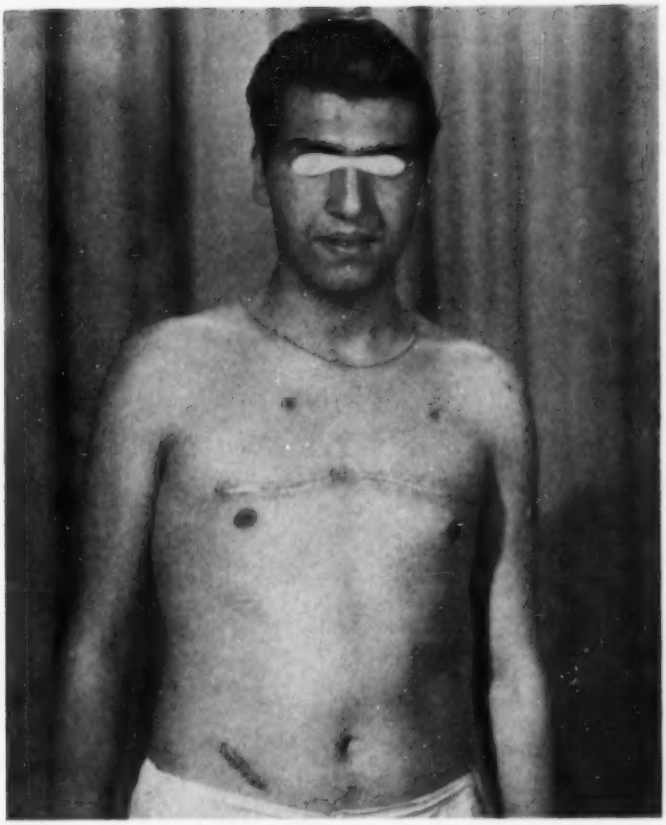


Fig. 5.—Photograph of a patient operated upon two years ago for pulmonary valve stenosis. The valve was exposed for 25 minutes.

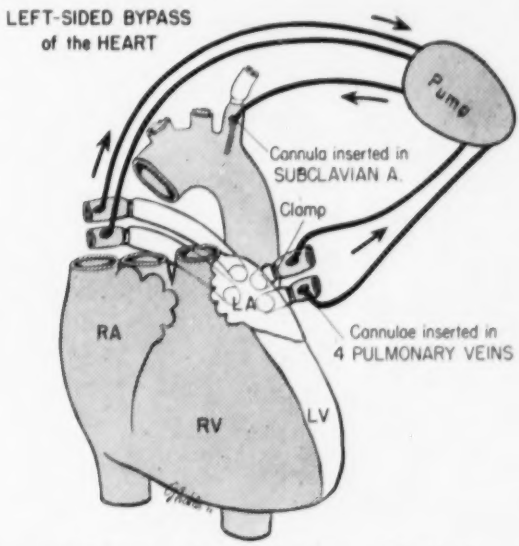
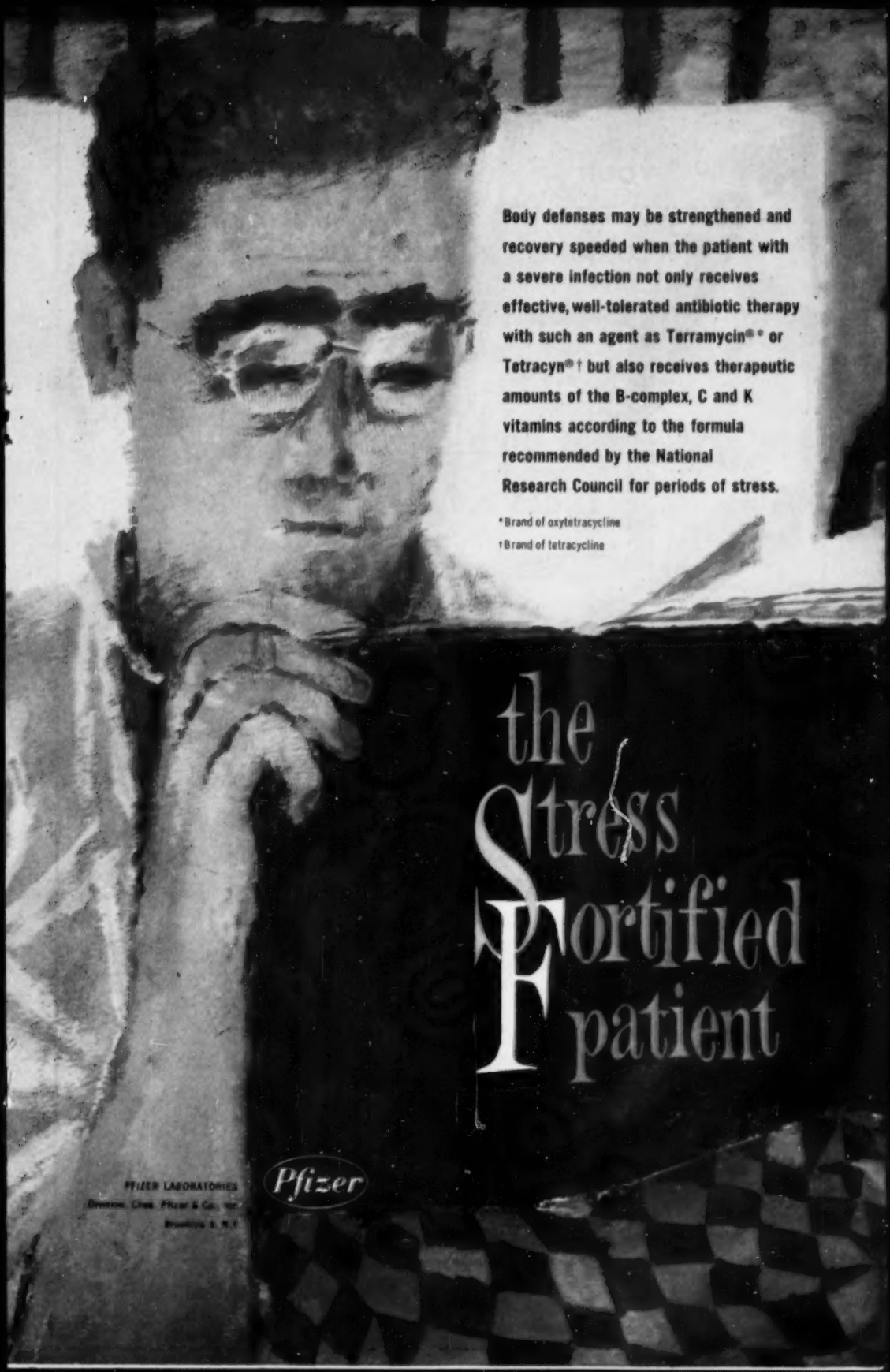


Fig. 6.—Diagrammatic illustration of a left-sided by-pass. The blood may be taken from the pulmonary veins or from the atrium.

Fig. 7.—The left atrium open while the mitral valve was exposed in a living patient.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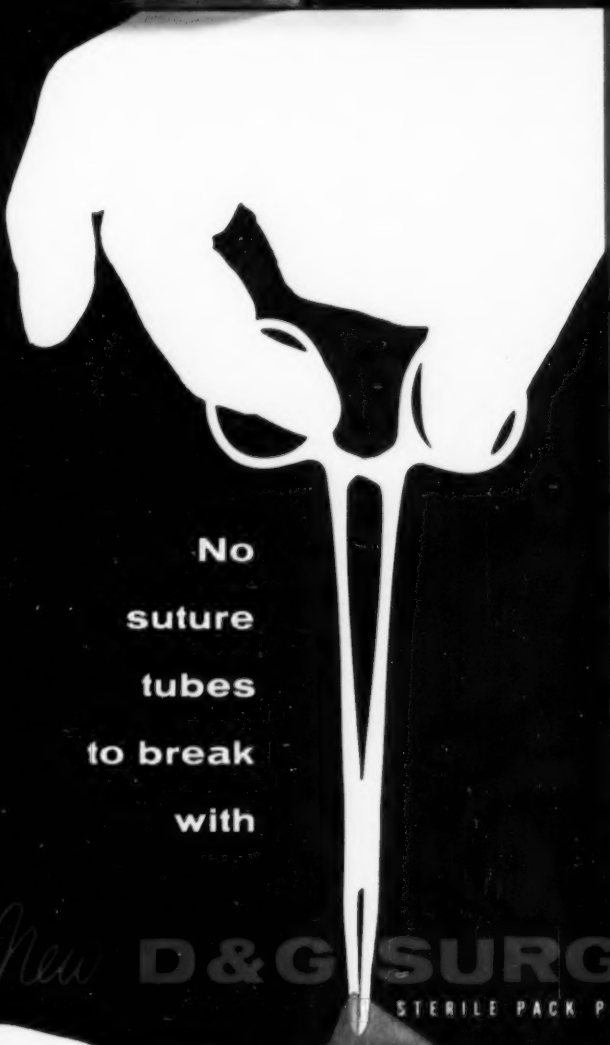

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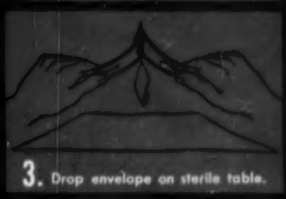

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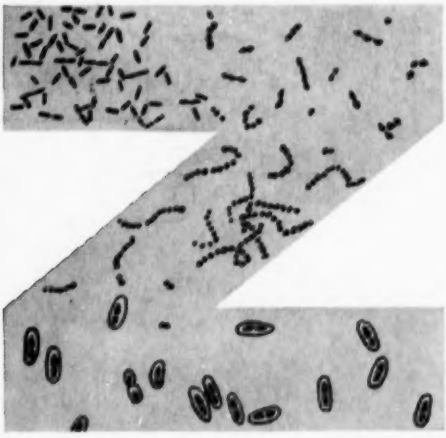

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